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A SINGULAR ANALYSIS OF THREE PLURALS

1. INTRODUCTION

The goal of this paper is to provide a single unified analysis of three different types of plural NPs. The first type are relational plurals, as in (1a), which have a reciprocal interpretation: on its relational (non-sortal) interpretation, (1a) denotes a group of individuals who are sisters *of each other* (see Dowty 1986, Eschenbach 1993, Hackl 2002 and Staroverov 2007). The second type are conjoined plural NPs with an additive interpretation, as in (1b), which denotes a group of individuals some of whom are men and some are women (see Heycock and Zamparelli 2000, 2003, 2005). The third type are NPs that are both relational *and* conjoined, as in (1c), which denotes a pair of individuals who are the husband and wife *of each other* (Staroverov 2007).

(1) a. the sisters [relational plural]
b. these men and women [conjoined plural]
c. a husband and wife [conjoined relational NP]

While these three types of plurals have received much attention in the semantic literature, no existing analysis has treated them all (one exception is Staroverov 2007, who gives a unified analysis to relational plurals and conjoined relational NPs, which, however, is not linked in any way to conjoined plurals like (1b)). Here, we provide a unified analysis of all three plural types, and furthermore capture the behavior of these three plurals when they occur with cardinals, as in (2).

(2) a. three sisters [relational plural]
b. seven men and women [conjoined plural]
c. three husbands and wives [conjoined relational NP]

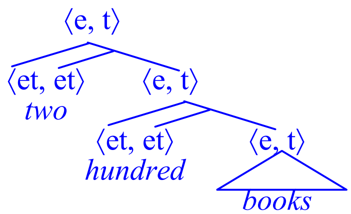
Our starting point is the hypothesis that morphological plural marking on the NP does not entail that the NP itself is semantically plural -- also presupposed by the claim (Ionin and Matushansky 2006) that cardinals combine with NPs that denote atomic sets. This hypothesis, coupled with independently motivated semantic operations, allows us to straightforwardly account for the behavior of both relational plurals and conjoined plurals. We analyze relational plurals as reflexive (rather than reciprocal, contra the analyses of Eschenbach 1993, Hackl 2002 and Staroverov 2007). To explain the interpretation of conjoined plurals, we adopt the analysis of "non-Boolean" additive conjunction from Winter 1996, 1998, 2001b. We demonstrate that the independent assumptions adopted in order to account for plural relational NPs and conjoined NPs are sufficient to compositionally derive the semantics of conjoined relational NPs with no additional stipulations. In addition, we can derive the fact that with conjoined relational NPs, it is pairs rather than individuals that are being counted: e.g., (2c) denotes six individuals, three husband-wife pairs (cf. Staroverov 2007).

This paper is organized as follows. Section 2 provides a brief summary of the analysis of cardinals from Ionin and Matushansky 2006, in particular those aspects relevant for our own proposal. In section 3, we give our analyses of relational plurals; section 4 gives our analysis of conjoined plurals, and shows how combining the proposed analyses of relational plurals and of conjoined plurals derives the interpretation of conjoined relational NPs. Section 5 considers alternative analyses of relational NPs, while section 6 concludes the paper.

2. BACKGROUND: SEMANTICS OF CARDINALS

We adopt the analysis of cardinal-containing NPs proposed by Ionin and Matushansky 2006. On this proposal, cardinal-containing NPs have a cascading structure, on which the lexical

NP combines directly with the lowest cardinal, as shown in (3).[1] Support for the cascading structure in (3), and against standard alternative analyses of cardinals (cardinals as functional heads, e.g., Ritter 1991, Barbiers 1992, Giusti 1997, Zamparelli 2002; and cardinals as specifiers of functional projections, e.g., Selkirk 1977, Franks 1994, Li 1999, Haegeman and Guéron 1999) comes from Case assignment facts cross-linguistically, in languages such as Russian and Inari Sami (Franks 1994, Nelson and Toivonen 2000, among others).

(3)


The cascading structure in (3) requires that simplex cardinals have the semantic type of modifiers, ⟨⟨e, t⟩, ⟨e, t⟩⟩. However, unlike Link 1987, Verkuyl 1997, and Landman 2003, Ionin and Matushansky 2006 do not propose that the cardinal combines with a plural NP to return a set of pluralities of the right cardinality. Instead, the solution proposed by Ionin and Matushansky 2006 is to treat simplex cardinals as subsective modifiers, as in the lexical entry in (4), where S is a partition Π of an entity x if it is a cover of x and its cells do not overlap (cf. Higginbotham 1981:110, Gillon 1984, Verkuyl and van der Does 1991, Schwarzschild 1994), as shown in (5)-(6).

(4) $[\![\text{two}]\!] = \lambda P \in D_{\langle e,t\rangle} . \lambda x \in D_e . \exists S \in D_{\langle e,t\rangle} [\, \Pi(S)(x) \wedge |S| = 2 \wedge \forall s \in S\ P(s)\,]$

(5) $\Pi(S)(x) = 1$ iff partition
S is a *cover* of x, and
$\forall z, y \in S\, [\, z=y \vee \neg\exists a\, [a \leq_i z \wedge a \leq_i y]]$ (Forbidding that cells of the partition overlap ensures that no element is counted twice.)

(6) A set of individuals C is a *cover of a plural individual* X iff
X is the sum of all members of C: $\bigsqcup C = X$

Having the semantic type of modifiers, cardinals necessitate a set-denoting argument, provided by its sister NP. As a result, an NP containing a complex cardinal, such as *two hundred books*, has the semantics in (7a), with the paraphrase in (7b).

(7) a. $[\![\text{two hundred books}]\!] = \lambda x \in D_e . \exists S_{\langle e,t\rangle}\ [\Pi(S)(x) \wedge |S| = 2 \wedge \forall s \in S\ \exists S'\ [\Pi(S')(s) \wedge |S'| = 100 \wedge \forall s' \in S'\ [\![\text{book}]\!](s') = 1]]$

b. $[\![\text{two hundred books}]\!] \approx \lambda x \in D_e$. x is a plural individual divisible into two non-intersecting non-empty sub-individuals p_i such that their union is x and each p_i is divisible into 100 non-intersecting non-empty sub-individuals p_j such their union is p_i and each p_j is **a book** (atom)

As shown above, the lexical entry in (4) requires that the lexical NP combining with a cardinal denote a set of atoms: the plural marking on the lexical NP in *two books* is analyzed by Ionin and Matushansky 2006 as an instance of agreement with the plurality of the entire DP, rather than the semantic plurality of the lexical NP itself. Support for this proposal comes from the fact that many languages that otherwise have plural marking (Finnish, Turkish,

[1] The structure in (3) is that of complex cardinals involving multiplication. Ionin and Matushansky 2006 analyze complex cardinals involving addition (e.g., *twenty-seven*) as having the syntax of (asyndetic) coordination. This is not directly relevant to our present purposes.

Hungarian) require the lexical NP combining with a cardinal to be morphologically singular (see Ionin and Matushansky 2006 for examples and discussion).

We follow Ionin and Matushansky 2006 in analyzing the lexical NP sister of a cardinal as semantically singular in all languages, including languages like English, where the lexical NP bears plural marking. As we discuss next, the assumption that morphological plural marking on a noun does not necessarily entail semantic plurality of that noun enables us to provide an analysis both of relational NPs and of conjoined NPs.

3. RELATIONAL NPS IN THE PLURAL

In this section, we focus on relational plural NPs of the kind illustrated in (8) (see Dowty 1986, Eschenbach 1993, Hackl 2002 and Staroverov 2007), which Hackl 2002 treats as a subtype of "essentially plural predicates", along with reciprocal verbs. The highlighted plural NPs in (8) are interpreted reciprocally: (8a) is about houses that are different *from each other*, (8b) is about sisters *of each other*, (8c) is about outcomes which are equally possible *with respect to each other*, and (8d) is about solutions which mutually exclude *each other*. The reciprocal interpretation is maintained when the NP is preceded by a cardinal, as in (9). On the other hand, the singular counterparts of these plurals either have a non-relational (sortal) interpretation (as in (10a-c)), or are infelicitous (as in (10d)).[2]

(8) a. My friends live in **different houses**.
b. I saw **sisters** walking down the street.
c. These are **equally possible outcomes**.
d. These are **mutually exclusive solutions**.

(9) a. My friends live in **five different houses**.
b. I saw **two sisters** walking down the street.
c. These are **seven equally possible outcomes**.
d. These are **four mutually exclusive solutions**.

(10) a. Sue lives in a different house (from the one Mary lives in).
b. I saw a sister (of John).
c. This is an equally possible outcome (to the one you mentioned).
d. *This is a mutually exclusive solution.

The analysis of Ionin and Matushansky 2006 that the lexical NP combining with a cardinal is semantically singular appears to face a problem with relational plural NPs that combine with cardinals, as in (9): how can the essential plurality of the lexical NP predicate in (9) be reconciled with the requirement that the lexical NP sister of a cardinal denote an atomic set?

In what follows, we will argue that relational plural NPs are not a problem for Ionin and Matushansky 2006 but that, conversely, treating the NP sister of a cardinal as atomic allows for a straightforward analysis of relational plurals.

3.1. Relational NPs: the proposal

The starting point of our proposal is the fairly obvious fact that in the singular, relational NPs require an internal argument, as shown in (11) (our focus here is on relational readings only; the relational NPs in (11) can also have sortal readings, e.g., *brother* in (11b) can mean somebody who is a member of the set of male individuals that have siblings, or a monk). This internal argument need not be explicit, and may be supplied by the context, as in (12), or the

[2] We are primarily concerned here with relational NPs denoting quasi-equivalence relations (Barker 1999). However, adjectives like *mutual*, *equal* and *reciprocal* and adverbs derived from them need not be contained in a plural NP (cf. *mutual distrust*, *reciprocal obligation*), though a plural licensor, explicit or implied, is nonetheless necessary. We believe that the analysis presented below can account for such uses as well.

verb *have*, as in (13). We further observe that relational NPs may have plural internal arguments, as in (14).

(11) a. Daniel's/*a sibling walked in.
b. Let's invite Edgar's/*a brother.

(12) a. A friend just called.
b. Let's invite a colleague.

(13) a. Everyone has a friend.
b. Thomas doesn't have a single colleague working on head-movement.

(14) a. Betsy and Claudia's sibling
b. their next-door neighbor

One way of pluralizing the external argument slot of the (transitive) predicate is via the star operator in (15) (Krifka 1986).[3] In order to pluralize its internal argument slot, we need a suitably modified star operator ($\overset{*}{\circ}$), as in (16).

(15) $[\![*]\!] = \lambda f \in D_{\langle e, t\rangle} . \lambda x \in D_e . f(x)=1 \text{ or } \exists x_1,x_2[x_1 \oplus x_2 = x \ \& \ {*f}(x_1) = {*f}(x_2) = 1]$

(16) $[\![\overset{*}{\circ}]\!] = \lambda f \in D_{\langle e, \langle e, t\rangle\rangle} . \lambda x \in D_e . \lambda y \in D_e . f(x)(y)=1 \text{ or } \exists x_1,x_2[x_1 \oplus x_2 = x \ \& \ \overset{*}{\circ}f(x_1)(y) = \overset{*}{\circ}f(x_2)(y) = 1]$

The operators in (15)-(16) reflect the fact that plurals can be interpreted distributively (the predicate applies to each individual in the plurality X), collectively (the predicate applies to the entire plurality X) or in an intermediate way (the predicate applies to the relevant sub-pluralities constituting the plurality X). The subset of relational nouns that we are concerned with, however, permits the distributive reading only: there are no relational nouns that, like the verbal predicate *combine*, would only be true of a plural internal argument. Furthermore, plural relational nouns only give rise to Strong Reciprocity (Langendoen 1978): assuming that *these people* in (17) refers to Annie, Bob, Claudia, Donovan, Elizabeth and Fred, (17) cannot possibly be true if there exists a pair of individuals in this group (for instance, Annie and Elizabeth) that aren't friends of each other, while all others are each other's friends.[4]

(17) These people are very good friends.

Strong Reciprocity means that instead of the star operators we could use the distributive operator DIST for both argument slots, as in (18), which will have the effect of rendering our semantic derivations easier to comprehend.

(18) a. $\text{DIST}_S = \lambda f \in D_{\langle e, t\rangle} . \lambda X \in D_e . \forall x \in X \ f(x)$
b. $\text{DIST}_O = \lambda f \in D_{\langle e, \langle e, t\rangle\rangle} . \lambda X \in D_e . \lambda y \in D_e . \forall x \in X \ f(x)(y)$

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[3] Another well-known alternative is the use of covers (Gillon 1984, 1987, Schwarzschild 1994, 1996). Since plural relational NPs that we are concerned with here are strongly reciprocal in the sense of Langendoen 1978, the choice between the two theories does not affect the final analysis.

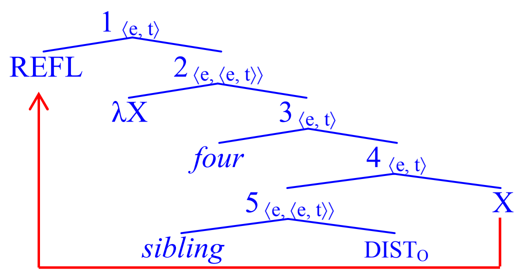
[4] There is some variability of judgments on this point: for some speakers, examples like (17) are felicitous even if there are some group members who are not each other's good friends (provided they are good friends of other members of the group). Such weak reciprocal readings are particularly likely to arise if the group under discussion is very large: e.g., with four people, (17) seems to require that they are all each other's very good friends, whereas with fifty people, some exceptions are allowed. This may be purely pragmatic (with a group of very large size, it is hard to imagine everyone being good friends of everyone else), or there may be genuine speaker variability in whether relational plurals are interpreted as strongly vs. weakly reciprocal. If indeed relational plurals are *not* strongly distributive, then we need to use the star operators ((15)-(16)) instead of the distributive operators in (18) in our derivations. Ultimately, this does not affect our proposal; we have chosen to use the distributive operators in our derivations for the sake of comprehensibility, but nothing in our analysis hinges on this choice.

We will presently show that the reflexive operator REFL, defined in (19), will suffice to derive the reciprocal interpretation of relational nouns, though the bulk of the motivation for its use will be presented in section 3.2. Crucially, we hypothesize that the reflexive operator can (and in our case, as we will show in the next section, must) QR.

(19) $[\![\text{REFL}]\!] = \lambda P_{\langle e, \langle e, t\rangle\rangle} . \lambda x . P(x,x)$

Putting together the DIST operator, the reflexive operator and the analysis of cardinals from Ionin and Matushansky 2006, we end up with the structure in (20) for *four siblings*.[5] As a result, the compositional semantics of (20) is spelled out in (21) and paraphrased informally in (22).

(20)



(21) a. $[\![\text{sibling}]\!] = \lambda x \in D_e . \lambda y \in D_e . \text{sibling}(x)(y)$
b. $[\![5]\!] = \lambda X \in D_e . \lambda y \in D_e . \forall x{\in}X\ \text{sibling}(x)(y)$
c. $[\![4]\!] = \lambda y \in D_e . \forall x{\in}X\ \text{sibling}(x)(y)$
d. $[\![3]\!] = \lambda Z{\in}D_e . \exists S{\in}D_{\langle e, t\rangle} [\, \Pi(S)(Z) \wedge |S| = 4 \wedge \forall s{\in}S\ \forall x{\in}X\ \text{sibling}(x)(s)\,]$
e. $[\![2]\!] = \lambda X . \lambda Z{\in}D_e . \exists S{\in}D_{\langle e, t\rangle} [\, \Pi(S)(Z) \wedge |S| = 4 \wedge \forall s{\in}S\ \forall x{\in}X\ \text{sibling}(x)(s)\,]$
f. $[\![1]\!] = \lambda X . \exists S{\in}D_{\langle e, t\rangle} [\, \Pi(S)(X) \wedge |S| = 4 \wedge \forall s{\in}S\ \forall x{\in}X\ \text{sibling}(x)(s)\,]$

(22) a set of plural individuals X such that there exists a partition of X into four non-intersecting non-empty parts s such that for every individual x in X, s is the sibling of x

However, the effect of using a reflexive operator together with distribution to atoms on both argument slots seems to give rise to truth conditions that are slightly stronger than we might wish: we are predicting that every individual in *four siblings* is also their own sibling. We will now show how this incorrect prediction is to be avoided.

3.2. The formal link between reflexives and reciprocals

It is well known that cross-linguistically, reflexive and reciprocal verbs often bear identical morphology. For instance, in Russian, the reflexive clitic *-sja* may, depending on the verb it combines with, correlate with reciprocal or reflexive interpretation, as illustrated in (23) (cf. Letuchiy 2009).[6]

(23) a. myt'-sja 'wash (oneself)', brit'-sja 'shave (oneself)' Letuchiy 2009
b. obnimat'-sja 'hug (each other)', celovat'-sja 'kiss (each other)'

Likewise, in French, a reciprocal or reflexive verb requires the presence of *se*, be the verb derived from a transitive stem, as in (24) and (25), or lexically/inherently reflexive or reciprocal, as in (26) and (27), respectively (Labelle 2008, see also Embick 1997a, 1997b).

[5] For the ease of exposition we represent the DIST_o operator as a syntactic node; the syntactic treatment of lambda-abstraction is as in Heim and Kratzer 1998. Nothing crucial depends on these assumptions.

[6] On the cross-linguistic morphosyntactic collapse of reflexive, reciprocal and anticausative verbs see, among others, Geniušienė 1987, Haspelmath 1987, 1990, 1993, and Embick 1997a, 1997b.

(24) a. *Le ministre copie lui-même. French: Labelle 2008
the minister copies him-self

b. Le ministre se copie.
the minister SE copies
'The minister copies himself.'

(25) a. *Les voisins détestent les uns les autres. French: Labelle 2008
the neighbors hate the ones the others

b. Les voisins se détestent (les uns les autres).
the neighbors SE hate the ones the others
'The neighbors hate each other.'

(26) a. *Jean autoanalyse.
Jean self-analyze-pres-3sg

b. Jean s' autoanalyse. French: Labelle 2008
Jean SE self-analyze-pres-3sg
'Jean analyzes himself.'

(27) a. *Les participants entreregardèrent.
the participants entre-look.at-past-3pl

b. Les participants s' entreregardèrent. French: Labelle 2008
the participants se entre-look.at-past-3pl
'The participants looked at one another.'

Setting aside the question of what the role of the reflexive clitic might be (see Reinhart and Siloni 2004 for some discussion), a comparison of the interpretation of a plural reflexive verb to that of a plural reciprocal verb immediately reveals the formal link between the two. The strong reciprocal interpretation is essentially a reflexive strong distribution down to atoms to the exclusion of atomic reflexives: i.e., the interpretation of (28a) presupposes that (28b) is untrue, as informally illustrated in (29). In other words, plural reciprocal VPs, just like plural relational NPs discussed above, can almost be treated as plural reflexives.

(28) a. The kids embraced (each other).
b. The kids embraced themselves.

(29) REFL (DIST_S (DIST_O (embrace))) (the kids) AND ¬ DIST_S (REFL (embrace)) (the kids)

Crucial here is the notion of irreflexivity introduced by Barker 1999. Both Barker 1999 and Hackl 2002 note that some relational nouns presuppose the non-identity relation between their arguments, viewed by both authors as part of their lexical entry: one can't be one's own sibling, child, or neighbor. While Barker 1999 explicitly constrains irreflexivity to some but not all relational nouns, we hypothesize that the presupposition of non-identity extends to all relational NPs.[7, 8] This means that upon plural reflexivization of a relational NP the "atomic

[7] Needless to say, this presupposition only concerns atomic arguments. It might seem at first sight that some relational nouns permit their two arguments to be identical (*I'm my own boss*, *He is his own worst enemy*, etc.). However, the fact that the presence of the emphatic adjective *own* is obligatory suggests that these apparent exceptions involve proxy interpretations (see Safir 2004, Reuland 2005, Reuland and Winter 2009) and therefore are not reflexive. An alternative hypothesis (Hackl 2002) is to appeal to individual concepts/guises.

[8] Some evidence in favor of postulating irreflexivity as an inherent property of all nouns comes from the interpretation of reflexive nouns and adjectives formed with the prefix *self-/auto*. Setting aside deverbal nouns and adjectives, such as *self-loader* or *self-destructive*, the residue are anticausative rather than reflexive (e.g., a *self-adhesive* paper does not adhere to itself, but rather *by* itself, without an external agent, and a *self-portrait* is not a portrait depicting the portrait itself). Interestingly, comparatives are also inherently irreflexive: e.g., *Sabine is smarter than anyone* clearly doesn't mean that Sabine is smarter than herself. Though the standard treatment

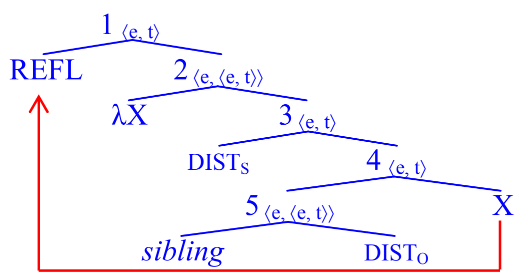
reflexive" (*R(x,x)*) is automatically excluded from consideration, and therefore the reciprocal reading is straightforwardly obtained as a result of reflexivization, as in (20) as well as in (30) below.[9]

Finally, the irreflexivity hypothesis also naturally explains why the reflexive operator in (20) and (30) can neither stay in situ nor move to position lower than the DIST_S operator or the cardinal. Though neither option is excluded on purely syntactic grounds,[10] a low position of the reflexive operator would lead to a violation of irreflexivity -- once again, on the assumption that irreflexivity is not a lexical property of some relational predicates, but rather an inherent property of all relational NPs. While we are convinced that such must be the case (see also footnote 8), we cannot advance any hypothesis for why this should be so.

3.3. Interim summary

To sum up, we derive the interpretation of cardinal-containing relational NPs by appealing to the subsective treatment of cardinals that imposes the atomicity constraint on the lexical NP of a cardinal, the QRing reflexive operator REFL, and the irreflexivity presupposition. Combining these pieces with a pluralizing operator, we are now able to also derive the correct meaning for plural relational NPs like *siblings,* as shown in (30). The derivation is given in (31), and the informal paraphrase – in (32).

(30)



(31) a. $[\![5]\!] = \lambda X \in D_e \,.\, \lambda y \in D_e \,.\, \forall x{\in}X \text{ sibling } (x)(y)$
b. $[\![4]\!] = \lambda y \in D_e \,.\, \forall x{\in}X \text{ sibling } (x)(y)$
c. $[\![3]\!] = \lambda Y \in D_e \,.\, \forall y{\in}Y\ \forall x{\in}X \text{ sibling } (x)(y)$
d. $[\![2]\!] = \lambda X \in D_e \,.\, \lambda Y \in D_e \,.\, \forall y{\in}Y\ \forall x{\in}X \text{ sibling } (x)(y)$
e. $[\![1]\!] = \lambda Y \in D_e \,.\, \forall x,y{\in}Y \text{ sibling } (x)(y)$

(32) a set of plural individuals X such that for any individuals x, y in X, x is a sibling of y

Importantly, every piece of this analysis is independently motivated: the star operator (Krifka 1986) or the simpler DIST_S operator and their extensions to the internal argument slot are needed for distributive readings elsewhere; the reflexive operator REFL is necessary in order to account for reflexive and reciprocal verbs; and the atomicity requirement is necessitated by the composition of complex cardinals (Ionin and Matushansky 2006). Finally, the reciprocal interpretation of the reflexive plural relational NP naturally follows from the

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of superlatives (see, e.g., Heim 1995/1999) has irreflexivity as part of the truth-conditions of the superlative morpheme, it should probably be taken as providing additional evidence for the hypothesis that superlatives are morphologically derived from comparatives (Stateva 2002 and Bobaljik 2007).

[9] It is tempting to hypothesize that verbs like *embrace* or *kiss* are inherently irreflexive, which is both eminently compatible with their semantics and provides a straightforward explanation for why the presence of a reflexive clitic on them gives rise to a reciprocal rather than reflexive interpretation in the plural (cf. Hackl 2002:177). Since this issue is very far removed from the topic of this paper, we set this hypothesis aside here.

[10] The configuration under discussion does not fall under the purview of i-within-i filter, since the QRing reflexive operator cannot be taken as the subject of the NP, and the subject of the NP does not bind its internal argument. As noted by Hackl 2002, such is not the case for his analysis.

independently motivated irreflexivity presupposition, which also explains why the reflexive cannot be merged below the cardinal in (20) (or the DIST operator in (30)).

Our analysis furthermore has the welcome consequence of being able to account for conjoined relational nouns. We turn to this next.

4. CONJOINED RELATIONAL NOUNS

We now move on to a discussion of conjoined relational NPs. As shown in (33), a conjunction of two singular relational NPs has a *reciprocal* reading. In (33a) (from Staroverov 2007), a conjunction of two relational nouns introduced by a singular indefinite article denotes a pair, with the reciprocal interpretation in (33b).

(33) a. The novel is about **a husband and wife**.
b. $\exists$Z [Z=x$\oplus$y and husband (x,y) and wife (y,x) and this novel is about Z]

Staroverov 2007 (p. 310) further observes that in a conjunction of plural relational NPs, as in (34), the plural conjoined NP denotes a set of brother-sister pairs, rather than a set of individual brothers and sisters (Staroverov attributes this observation to Sergei Tatevosov). We note further that if a conjunction of two relational NPs is introduced by a cardinal, it is pairs, rather than individuals, that are counted, as shown in (35).

(34) We want brothers and sisters for the roles of the peasants. They should look like relatives.

(35) a. two mothers and daughters = four people, two reciprocal mother-daughter pairs
b. three husbands and wives = six people, three reciprocal husband-wife pairs

As observed by Hackl 2002, "essentially plural predicates", like *sisters*, pose a problem for the standard analysis of cardinals: the minimal unit of "reciprocal sisters" is a pair, which should predict that *three sisters* denotes six rather than three people. We have overcome this problem by providing an alternative analysis of such "essentially plural predicates", but the question now arises whether we will be able to count pairs with conjoined relational nouns. First, however, we need to discuss conjoined non-relational nouns; we will propose an analysis of conjoined plurals such as *men and women* which also derives the interpretation of conjoined relational NPs.

4.1. Conjoined interpretation of non-relational NPs

Heycock and Zamparelli 2000, 2003, 2005 discuss the fact that conjoined NPs can have either intersective or additive readings (which Heycock and Zamparelli term the *joint* and *split* readings, respectively), as shown in (36). In (36a), the conjoined NP has an intersective reading: the same individual is both a liar and a cheat. In contrast, (36b-c) are examples of additive readings: e.g., in (36), the properties of ‘doctor’ and ‘dentist’ are borne by two different individuals; similarly, in (36c), some individuals are men and some are women. While in (36a-b), agreement marking on the verb disambiguates in favor of either the intersective or the additive reading, in (36c), the intersective reading is ruled out by pragmatic considerations (since no individual can be both a man and a woman at once). Sentences like (36d) are ambiguous between the two readings: (36d) can mean either that a person who is both a soldier and a sailor came home (37a), or that two people, one a soldier and the other sailor, came home (37b).

(36) a. That liar and cheat is not to be trusted. [intersective]
b. My doctor and dentist are both sailors. [additive]
c. The men and women sat down to lunch. [additive]
d. The soldier and sailor came home from the voyage. [ambiguous]

(37) a. λx. soldier (x) & sailor (x) [intersective]
b. λX. X=y$\oplus$z & soldier (y) & sailor (z) [additive]

4.1.1. Set product

As is easy to see, the standard Boolean semantics of *and* provides the correct truth-conditions for intersective readings but not for additive readings. Heycock and Zamparelli 2000, 2003, 2005 derive both types of readings by assuming that *and* returns a set-product, as defined in (38).

(38) Set-product (SP)
SP (A1, …An) =def {X : X=a1 $\cup$ … $\cup$ an, a1 $\in$ A1, … an $\in$ An }

To illustrate how set product works, consider the three sample scenarios in (39), based on Heycock and Zamparelli 2000, 2003, 2005, for the singular NP-coordination of *soldier and sailor*. In (39a), the set of soldiers and the set of sailors are completely disjoint; the set product operation therefore results in *soldier and sailor* denoting a set of pairs, where one member of a pair is a soldier and the other – a sailor. Thus, *the soldier and sailor* will necessarily denote a pair of individuals: this is the additive reading. Its opposite is in (39b): here, the two sets denoted by *soldier* and *sailor* are identical. Therefore, *soldier and sailor* now denotes a set consisting both of single individuals (each of whom is a soldier and a sailor at once), and of pairs of individuals (where one member is a soldier, and the other – a sailor). As a result, *the soldier and sailor* could, in this scenario, denote either a single individual (the intersective reading) or a pair of individuals (the additive reading). Finally, (39c) represents a case of partial overlap between the two sets; once again, both intersective and additive readings result. Coordination of plural NPs (e.g., *soldiers and sailors*) works analogously, except that, after application of the pluralizing operator, the resulting set contains all the possible sets which consist of at least one soldier and at least one sailor.

(39) a. ⟦soldier⟧={{a}, {b}, {c}}, ⟦sailor⟧={{m}, {n}, {o}}
⟦soldier and sailor⟧=SP(⟦soldier⟧,⟦sailor⟧)={{a,m},{a,n},{a,o},{b,m}, {b,n},{b,o},{c,m},{c,n},{c,o}}

b. ⟦soldier⟧={{a}, {b}, {c}}, ⟦sailor⟧={{a}, {b}, {c}}
⟦soldier and sailor⟧= SP(⟦soldier⟧,⟦sailor⟧)={{a},{b},{c},{a,b},{a,c},{b,c}}

c. ⟦soldier⟧={{a}, {b}, {c}}, ⟦sailor⟧={{b}, {c}, {d}}
⟦soldier and sailor⟧= SP(⟦soldier⟧,⟦sailor⟧)={{b},{c},{a,b},{a,c},{a,d}, {b,c},{b,d},{c,d}}

Staroverov 2007 clearly demonstrates that standard analyses of intersective and additive readings (Winter 1995, 1996, 1998, 2001a, Heycock and Zamparelli 2000, 2003, 2005) cannot account for reciprocal readings, such as (33). We propose an alternative analysis of NP-coordination which, as we will show, is able to derive the readings for of non-relational plural conjoined NPs, and of relational conjoined NPs.

4.1.2. Disjunctive *and*

As discussed above, the standard Boolean *and* cannot derive the additive interpretation of conjoined NPs. We propose that these require the non-Boolean (additive) interpretation of *and* (cf. Krifka 1990), which is also necessary for the interpretation of the conjunction of argument proper names, as in (40), which, under standard assumptions, cannot be treated as predicates.

(40) Mary and John slept.

While many authors assume ambiguity between Boolean and non-Boolean *and*, Winter 1996 provides a straightforward way of reducing the "additive" *and* to the Boolean *and*: as proposed by Partee and Rooth 1983, an NP denoting an entity (type e) can be shifted to the Generalized Quantifier type ⟨⟨e, t⟩, t⟩ via the operation of "Montague Raising", as in (41).

(41) m' → λP.P(m')=M

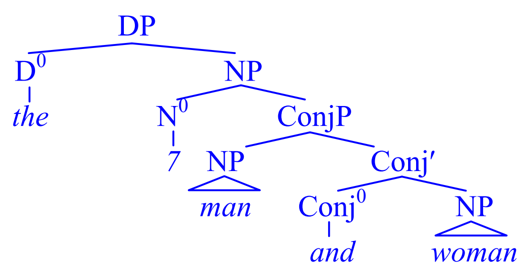
If both type *e* constants in (40) are lifted via "Montague Raising" into the Generalized Quantifier type, the Boolean *and* can combine with them, with the derivation in (42) for (40) (Winter 1996:353).

(42) [Mary Π John] sleep' ⇔ (λP. P(m') ∧ P(j')) sleep' ⇔ sleep(m') ∧ sleep(j')

The additive interpretation of *and* is precisely what we need for the interpretation of examples like (43). We start with the conjoined cardinal-containing NP, as in (43b). Per the hypothesis of Ionin and Matushansky 2006, discussed in Section 2, plural marking on an NP-sister of a cardinal is due to agreement, and does not entail the presence of the pluralizing operator on that NP. This means that the semantic representation of (43b) involves the coordination of two singulars, as shown in (44).

(43) a. The streets and squares were extremely dirty. [additive]
b. The seven men and women are smiling for the camera. [additive]

(44)



To derive (43b), we start with the coordination of two singular kinds: the kind *man* and the kind *woman*, derived via the *down* operator (Chierchia 1984, 1998), which shifts properties to kinds.[11] As is easy to see, if a singular noun can be treated as a kind and therefore, a type of an entity (Chierchia 1984, 1998), its denotation can then be shifted to the generalized quantifier type, yielding an "additive" interpretation: a "plural kind" Generalized Quantifier, as in (45a). Following Partee 1986, we assume the operation *lower* that maps a Generalized Quantifier generated from an entity (a principal ultrafilter) onto its generator and hypothesize that it can also apply to the Generalized Quantifier resulting from kind-coordination. As a result, the NP conjunction *man and woman* denotes a plural kind, which is comprised of the kind *man* together with the kind *woman*; just as *Mary and John* denotes a plural individual, which is comprised of the individuals John and Mary.

[11] Additive readings are also available to modified NPs (e.g., *the tall giraffes and large elephants*), which are generally assumed not to denote kinds (unlike NPs containing relational adjectives, McNally and Boleda 2004). This suggests that what we really require is not a kind, but rather a concept (Krifka 1995, Bouchard 2002, 2005), since concepts can be formed on the basis of modified NPs. Alternatively, we could use the *nom* operation (Chierchia 1984, Partee 1986), which turns properties into their entity-correlates, and which can apply to any property-denoting expression, not just NPs. Support for this possibility comes from the fact that APs and PPs also have additive readings (Artstein 2002): e.g., *Students from Germany and from Switzerland met at the conference*; *The children are tall and short*.

Ultimately, whether we treat *man and woman* as coordination of kinds, or as coordination of concepts, or as coordination of entity-correlates of the corresponding properties (derived via the *nom* operation), does not affect our proposal.

Following Chierchia 1984 and Partee 1986, we use the operation *pred* to pass from the kind interpretation to the property interpretation, except the property now denotes a set of individuals in the extension of the two combined kinds. Now, *man and woman* denotes a set of individuals each of whom is a member of the kind *man* or a member of the kind *woman* – i.e., each of whom is a man or a woman, as in (45b).

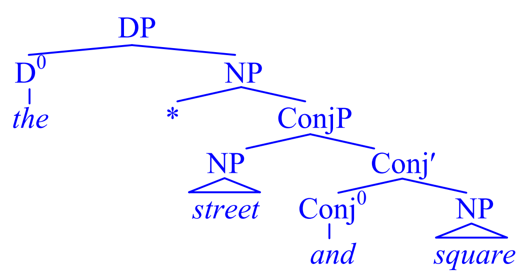
(45) a. $[\![\text{man and woman}]\!] = \text{man}_{\text{kind}} \oplus \text{woman}_{\text{kind}}$
b. $[\![\text{man and woman}]\!] = \lambda x.\ \text{man}(x) \vee \text{woman}(x)$

The NP *man and woman* can now combine with the cardinal *seven*, resulting in a set of plural individuals, each of which consists of seven non-intersecting parts, where each part is either a man or a woman, as shown in (46a). Combining with the definite determiner, *the seven men and women* has the semantics in (46b), paraphrased informally in (46c).

(46) a. $\lambda x{\in}D_e\,.\ \exists S{\in}D_{\langle e,\,t\rangle}\ [\ \Pi(S)(x) \wedge |S| = 7 \wedge \forall s{\in}S\ [[\![\text{man}]\!](s) \text{ or } [\![\text{woman}]\!](s)]]$
b. $\iota x,\ \exists S{\in}D_{\langle e,\,t\rangle}\ [\ \Pi(S)(x) \wedge |S| = 7 \wedge \forall s{\in}S\ [[\![\text{man}]\!](s) \text{ or } [\![\text{woman}]\!](s)]]$
c. the unique plural individual divisible into seven non-intersecting parts, each of whom is a man or a woman

Building on the previous discussion, we assume that plural marking on nouns may be semantically vacuous and purely reflect agreement with the pluralizing operator even in those cases where a cardinal is not present, such as (43a). The resulting tree is given in (47), we are once again dealing with coordination of two singular kinds (the *street* kind and the *square* kind), as before. Passing from kinds to properties, we have the additive interpretation – a set of individuals each of which is a street or a square. Now, we apply the pluralizing operator in (15), obtaining set of plural individuals each of which is two or more streets and/or squares, as in (48a). Combining with the definite determiner, *the streets and squares* has the semantics in (48b), paraphrased informally in (48c).[12]

(47)



(48) a. $\lambda x{\in}D_e\,.$ [x is a street or x is a square] or $\exists x_1,x_2[x_1 \oplus x_2 = x$ & *[x_1 is a street or x_1 is a square] and *[x_2 is a street or x_2 is a square]]

b. ιx, [x is a street or x is a square] or $\exists x_1,x_2[x_1 \oplus x_2 = x$ & *[x_1 is a street or x_1 is a square] and *[x_2 is a street or x_2 is a square]]

c. the maximal plural individual each of whose subparts is a street or a square

It seems that the truth-conditions that we have achieved are not sufficiently precise: it now becomes possible for *streets and squares,* or *seven streets and squares*, to consist uniquely of streets or of squares. Contrary to the first impression, however, this is a welcome result. While in a situation where it is known that we are talking about seven streets only, it is pragmatically odd to talk about seven streets and squares, under other circumstances *seven streets and squares* may indeed refer to seven streets only. Suppose that a presenter on a TV program coming out weekly upon each occasion randomly selects seven streets and squares

[12] Since plural NPs (to the exception of quasi-equivalence relations) may allow collective interpretations (Gillon 1987), in order to not prejudge the issue we return here to the use of the star operator rather than DIST.

to discuss, as in (49). Although upon some occasions obviously only streets or only squares will be discussed, (49) can still be used, showing that our truth-conditions are indeed correct.

(49) And each time she finds something interesting to tell about each of these seven streets and squares!

Other examples of this type are found in (50). For example, (50a) is clearly intended to convey that seeing just men, or just women, or both men and women, working at desks would all lead to the conclusion the location is an office. Similarly, in (50b), the earning of 20 cents follows if ten individuals, regardless of their gender, complete the necessary steps.

(50) a. If you see men and women working at desks with computers, you can assume the location is an office. (http://vickyzhu.blogspot.com/2010/06/how-to-analyze-pictures-in-doing-toeic.html)
b. Imagine if ten men and women register under you. If they review all 4 ads, it's $ 0.20 (twenty cents) for you (clickbanktrafficwarrior.net/neobux-guide-and-strategy/)

The reading on which *men and women* or *ten men and women* is allowed to consist exclusively of men or exclusively of women cannot be derived via Heycock and Zamparelli's set product: a set product of *men and women* necessarily consists of sets each of which contains at least one man and at least one woman. Thus, our application of Winter's *and* to plural NP conjunctions has the welcome advantage of deriving a reading not derived by the set product operation. We will next show that Winter's *and*, coupled with our analysis of relational plurals, can also successfully derive conjoined relational NPs.[13]

4.2. Analysis of conjoined singular relational NPs

Our treatment of plural relational NPs, coupled with our analysis of conjoined plurals (above) straightforwardly derives the interpretation of conjoined relational NPs, under the assumption that the interpretation of conjoined relational NPs also involves the plural reflexive operator modulo irreflexivity. The conjoined NP in (33a) has the derivation in (51), spelled out in (52). Each relational NP is combined with the DIST_{O} operator (52a), and then takes a plural argument (52b), exactly as in the case of *siblings* (see (20) and (30)).

[13] We note that Winter's *and* cannot derive the additive readings of conjoined singular non-relational NPs, as in (36b,d). Application of Winter's *and* to *soldier and sailor* would result in the coordination of the soldier-kind and the sailor-kind. Using *pred* to shift from kinds to predicates, we obtain a set of individuals each of whom is either a member of the kind *soldier* or a member of the kind *sailor*, as in (ia); *the soldier and sailor* would then have the interpretation in (ib), denoting the unique individual who is either a soldier or a sailor. However, this reading is clearly unavailable: *the soldier and sailor* is ambiguous between the intersective reading (on which the same individual is both a soldier *and* a sailor) and the additive reading (on which it denotes two individuals, one a soldier the other a sailor); (ib) does not correspond to either of these readings, and indeed the additive reading cannot be straightforwardly derived on the 'disjunctive *and*' account. The additive reading can, however, be derived via the set product operation, as shown in (39).

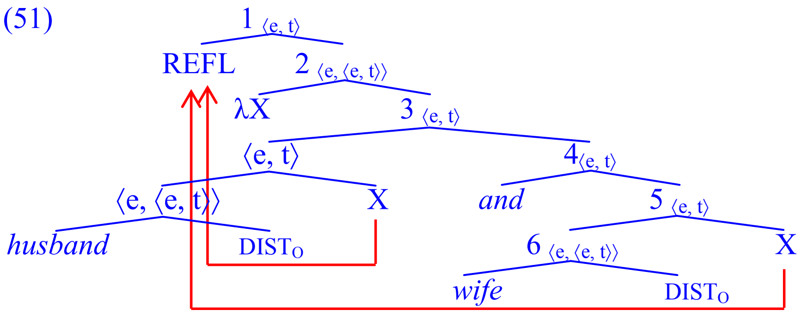
(i) a. $\lambda x.\ \text{soldier}(x) \vee \text{sailor}(x)$
b. $\iota x,\ \text{soldier}(x) \vee \text{sailor}(x)$

We note that, at the same time, the disjunctive reading *is* available to singular NPs with *every*, as in (ii). For example, (iia) can be paraphrased as *Every individual who is either a boy or a girl falls in love* – precisely the reading derived by Winter's *and*. Set product would instead derive the additive reading on which every boy-girl pair falls in love – which is not what (iia) means. Even more clearly, (iib) means that every individual boy or girl who enters the room receives a prize, and not that every boy-girl pair receives a prize.

(ii) a. Every boy and girl falls in love.
b. Every boy and girl who enters the room receives a prize.

We leave the analysis of conjoined singular non-relational NP open for further investigation.

(51)



(52) a. $[\![6]\!] = \lambda X \in D_e \,.\, \lambda y \in D_e \,.\, \forall x \in X \text{ wife } (x)(y)$
b. $[\![5]\!] = \lambda y \in D_e \,.\, \forall x \in X \text{ wife } (x)(y)$

Next, the two NPs, which now have type ⟨e, t⟩, are combined via Winter's *and*, exactly as in the case of *men and women*, described in the previous section. First, the NPs are shifted from properties to kinds via the down operator (53a). Winter's non-Boolean *and* can then apply, combining the two singular kinds into a plural kind (which consists of the husband-kind plus the wife-kind, (53b-c)).

(53) a. $\text{down } ([\![5]\!]) = \text{down } (\lambda y \in D_e \,.\, \forall x \in X \text{ wife } (x)(y))$
b. $[\![4]\!] = \lambda z \in D_e \,.\, z \oplus \text{down } (\lambda y \in D_e \,.\, \forall x \in X \text{ wife } (x)(y))$
c. $[\![3]\!] = \text{down } (\lambda y \in D_e \,.\, \forall x \in X \text{ husband } (x)(y)) \oplus \text{down } (\lambda y \in D_e \,.\, \forall x \in X \text{ wife } (x)(y))$

Then this plural kind is, via *pred*, shifted back to a property -- a set whose members are either instantiations of the wife-kind or instantiations of the husband-kind (54a); the saturation of the internal argument is irrelevant for these processes. From here, the derivation proceeds exactly as in the case of *siblings* (54b-c). The resulting NP *husband and wife* can then combine with a determiner: for example, *the husband and wife* has the semantics in (54d).

(54) a. $\text{pred } ([\![3]\!]) = \lambda y \in D_e \,.\, \forall x \in X \text{ husband } (x)(y) \vee \text{wife } (x)(y)$
b. $[\![2]\!] = \lambda X \in D_e \,.\, \lambda y \in D_e \,.\, \forall x \in X \text{ husband } (x)(y) \vee \text{wife } (x)(y)$
c. $[\![1]\!] = \lambda Y \in D_e \,.\, \forall x \in Y \text{ husband } (x)(Y) \vee \text{wife } (x)(Y)$
d. $[\![\text{the husband and wife}]\!] = \iota X : \forall x \in X \text{ husband } (x)(X) \vee \text{wife } (x)(X)$

Importantly, despite the absence of a pluralizing operator in (54c), the unique/external argument of the reciprocal is plural (a husband-wife pair) because the internal arguments of the two relational nouns are. This means that the external argument of *husband/wife* should also be plural, even though the predicate has not been realized for the external argument slot. The atomic irreflexivity of relational nouns means that both of these conditions will only be met for husband-wife pairs:

(55) $[\![1]\!] (M\oplus J) = 1 \text{ iff } \forall x \in M\oplus J \,[\text{husband } (x)(M\oplus J) \vee \text{wife } (x)(M\oplus J)]$

Indeed, (55) will be true for the couple Mike and Jennifer: for every individual in M⊕J it is true that the plural individual M⊕J is either their husband or their wife. If the predicate *husband* has Jennifer as its internal argument, then irreflexivity of relational nouns entails that when the predicate *λy . husband(Jennifer)(y)* is saturated with the plural individual M⊕J, Jennifer is automatically excluded from consideration, and therefore only the truth value of *husband (Jennifer)(Mike)* is evaluated; the external argument of *husband* has turned into a singular.

Conversely, the plural individual Mike, Albert and Jennifer (or any plural individual consisting of more than two members) cannot function as an external argument in (54c), as shown in (56).

(56) ⟦1⟧ (M⊕A⊕J) = 1 iff ∀x ∈ M⊕A⊕J husband (x)(M⊕A⊕J) ∨ wife (x)(M⊕A⊕J)

Once again, the hypothesis that we have constructed above entails that the predicate *λy . husband(Jennifer)(y)*, although singular, applies to a plural individual, M⊕A⊕J. The atomic irreflexivity of relational nouns means that Jennifer is excluded from consideration, but the predicate is still required to apply to a plural individual, M⊕A, which it cannot do. In other words, the domain of the predicate in (54c) contains only plural individuals of the cardinality two, and as a result, husband-wife pairs are minimal units in the denotation of the conjoined singular relational NP in (51), which both permits the use of the indefinite singular article *a* and allows the use of (54c) for counting -- it is an atomic set. Interestingly, Staroverov 2007 observes that a three-member coordination (e.g., *a husband, wife and child*) has no reciprocal reading, which is now correctly predicted: as shown above, the use of atomic irreflexivity to enable a singular predicate to apply to a plural individual is only possible for pairs.

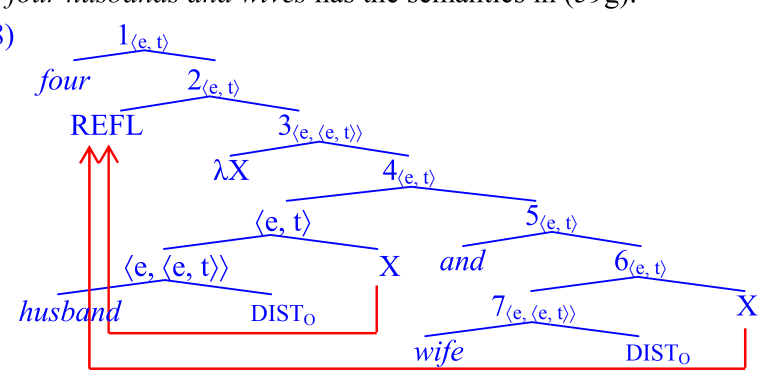
4.3. Analysis of conjoined plural relational NPs

Starting with cardinal-containing NPs, three different types of reciprocal interpretations are available to conjoined relational NPs, in (57).

(57) a. four husbands and wives = four husband-wife pairs
b. four brothers and colleagues = four people, both brothers and colleagues of each other
c. four brothers and sisters =four people, each of whom is a brother or sister of the others

First, there is the reading of reciprocal pairs, available to (57a); this reading is in principle also available to (57c) (on this reading, (57c) would denote four brother-sister pairs) – however, it is not the most salient reading of (57c), because brothers and sisters, unlike husbands and wives, do not naturally come in pairs. The reciprocal-pair reading is unavailable to (57b), since *brother and colleague* is not a reciprocal relationship (i.e., if x is y's brother, it does not follow that y is x's colleague). The reading that (57b) does have available to it is the intersective reciprocal reading, on which each individual among the four is both a brother and a colleague of the others. This reading is unavailable to (57a,c), since no individual can be a husband and a wife at once, or a brother and a sister at once. Finally, (57c) has available to this the interpretation on which each individual among the four is either a brother or a sister of the others. This reading is in principle available to (57a), although it is not a salient reading in our monogamous society. For (57b), this reading is once again odd, since *brother and colleague* is not a natural reciprocal relationship (i.e., it is odd to specify that each group member is either a brother or a colleague of the others). The only difference between the last two readings (57b-c) is whether *and* is interpreted intersectively or distinctively.

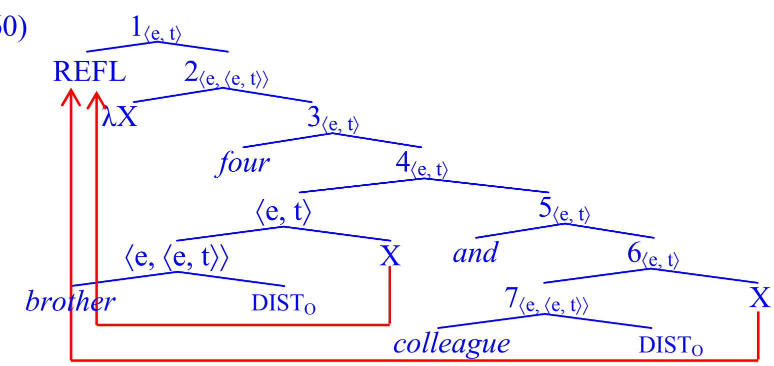
All three readings in (57) are straightforwardly derivable on our analysis. We start with (57a), which we derive by using the structure in (51) and combining it with the cardinal, as shown in (58), with the step-by-step derivation in (59); combining with a definite determiner, *the four husbands and wives* has the semantics in (59g).

(58)


(59) a. $[\![7]\!] = \lambda X \in D_e \,.\, \lambda y \in D_e \,.\, \forall x \in X$ wife (x)(y)
b. $[\![6]\!] = \lambda y \in D_e \,.\, \forall x \in X$ wife (x)(y)
c. $[\![5]\!] = \lambda z \in D_e \,.\, z \oplus$down $(\lambda y \in D_e \,.\, \forall x \in X$ wife (x)(y))
d. $[\![4]\!] = \lambda y \in D_e \,.\, \forall x \in X$ husband (x)(y) $\vee$ wife (x)(y)
e. $[\![3]\!] = \lambda X \in D_e \,.\, \lambda y \in D_e \,.\, \forall x \in X$ husband (x)(y) $\vee$ wife (x)(y)
f. $[\![2]\!] = \lambda Y \in D_e \,.\, \forall x \in Y$ husband (x)(Y) $\vee$ wife (x)(Y)
g. $[\![1]\!] = \lambda Y \in D_e \,.\, \exists S \in D_{\langle e,\, t\rangle}$ [Π(S)(Y) $\wedge$ |S| = 4 $\wedge$ $\forall s \in S$ [$\forall x \in s$ husband (x)(s) $\vee$ wife (x)(s)]
h. the unique plural individual Y, such that Y is divisible into four non-intersecting non-empty parts s, such that for all x in s, x is a husband of s or x is a wife of s.

In (58), the reflexive operator merges lower than the cardinal, in order to derive the right interpretation for (57a). It is also possible to merge REFL above the cardinal, in which case we yield the interpretation in (57b), as shown in (60), with the step-by-step derivation in (61) In order to derive the intersective reading of *four brothers and colleagues*, we use the standard Boolean *and* in (61). The semantics of *the four brothers and colleagues* is given in (61h).

(60)



(61) a. $[\![7]\!] = \lambda X \in D_e \,.\, \lambda y \in D_e \,.\, \forall x \in X$ colleague (x)(y)
b. $[\![6]\!]) = \lambda y \in D_e \,.\, \forall x \in X$ colleague (x)(y)
c. $[\![5]\!] = \lambda f \in D_{\langle e,\, t\rangle} \,.\, f \wedge \lambda y \in D_e \,.\, \forall x \in X$ colleague (x)(y))
d. $[\![4]\!] = \lambda y \in D_e \,.\, \forall x \in X$ brother (x)(y) $\wedge$ colleague (x)(y)
e. $[\![3]\!] = \lambda Z \in D_e \,.\, \exists S \in D_{\langle e,\, t\rangle}$ [Π(S)(Z) $\wedge$ |S| = 4 $\wedge$ $\forall s \in S$ [$\forall x \in X$ brother (x)(s) $\wedge$ colleague (x)(s))]]
f. $[\![2]\!] = \lambda X \in D_e \,.\, \lambda Z \in D_e \,.\, \exists S \in D_{\langle e,\, t\rangle}$ [Π(S)(Z) $\wedge$ |S| = 4 $\wedge$ $\forall s \in S$ [$\forall x \in X$ brother (x)(s) $\wedge$ colleague (x)(s))]]
g. $[\![1]\!] = \lambda Y.\ \exists S \in D_{\langle e,\, t\rangle}$ [Π(S)(Y) $\wedge$ |S| = 4 $\wedge$ $\forall s \in S$ [$\forall y \in Y$ brother (y)(s) $\wedge$ colleague (y)(s))]]
h. the unique plural individual Y, such that Y is divisible into four non-intersecting non-empty parts s, such that for every individual part y of Y, y is a brother of s and y is a colleague of s.

Finally, we consider the interpretation of (57c), which requires that *and* be interpreted disjunctively. Its structure being identical to (60) modulo different lexical items, we simply present the derivation here. The application of *down* and *pred* operators is incorporated into the derivations to yield the disjunctive reading of *and*, as shown in (62).

(62) a. $[\![7]\!] = \lambda X \in D_e \,.\, \lambda y \in D_e \,.\, \forall x \in X$ sister (x)(y)
b. $[\![6]\!] = \lambda y \in D_e \,.\, \forall x \in X$ sister (x)(y))
c. $[\![5]\!] = \lambda f \in D_{\langle e,\, t\rangle} \,.\,$ f or $\lambda y \in D_e \,.\, \forall x \in X$ sister (x)(y)
d. $[\![4]\!] = \lambda y \in D_e \,.\, \forall x \in X$ brother (x)(y) $\vee$ sister (x)(y)
e. $[\![3]\!] = \lambda Z \in D_e \,.\, \exists S \in D_{\langle e,\, t\rangle}$ [Π(S)(Z) $\wedge$ |S| = 4 $\wedge$ $\forall s \in S$ [$\forall x \in X$ brother (x)(s) $\vee$ sister (x)(s))]]

f. ⟦2⟧ = $\lambda X \in D_e . \lambda Z \in D_e . \exists S \in D_{\langle e, t\rangle}$ [$\Pi(S)(Z) \wedge |S| = 4 \wedge \forall s \in S$ [$\forall x \in X$ brother (x)(s) $\vee$ sister (x)(s))]]
g. ⟦1⟧ = $\lambda Y. \exists S \in D_{\langle e, t\rangle}$ [$\Pi(S)(Y) \wedge |S| = 4 \wedge \forall s \in S$ [$\forall y \in Y$ brother (y)(s) $\vee$ sister (y)(s))]]
h. the unique plural individual Y, such that Y is divisible into four non-intersecting non-empty parts s, such that for every individual part y of Y, y is a brother of s or y is a sister of s.

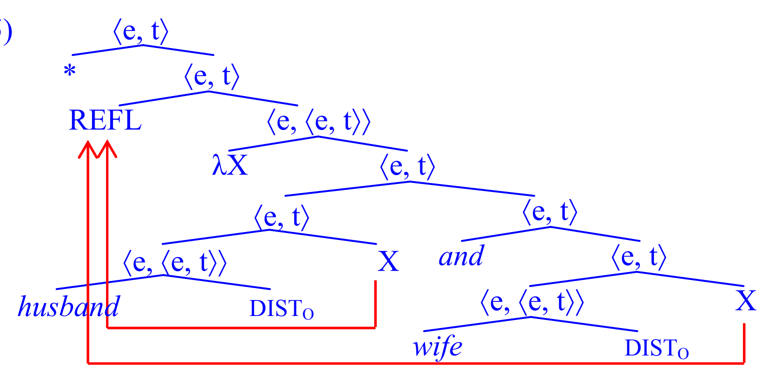
Finally, we note that with higher numbers, counting pairs becomes difficult, and a sortal (non-reciprocal) interpretation becomes more salient. Thus, while the preferred interpretation of (63a) is the reciprocal-pair interpretation, the preferred interpretation of (63b) is that 17 individuals live in the house, with each of them a mother or a daughter, not necessarily of one another.

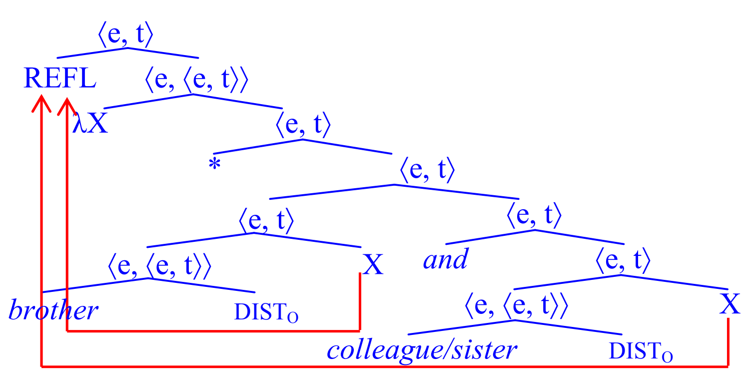
(63) a. Four mothers and daughters are living in this house. = 4 mother-daughter pairs
b. 17 mothers and daughters are living in this house. = 17 individuals, each of whom is a mother or a daughter

Exactly the same treatment is used for conjoined relational NPs without cardinals, as in (64): the three readings in (57a-c) are also available to (64a-c), respectively.

(64) a. I know these husbands and wives.
b. I know these brothers and colleagues.
c. I know these brothers and sisters.

As in parallel derivations above, while in (64a), the reflexive operator scopes below the star operator (as in (65)), in (64b-c), the former outscopes the latter (as in (66)). The differing interpretations of (64b) and (64c) are due to the intersective or disjunctive interpretation of *and*.

(65)


(66)


We hypothesize that the interpretation in (64c), involving as it does additional type-shifting operations, only becomes available when the interpretation in (64b) is excluded by the lexical semantics of the nouns involved: since it is impossible to be a brother and a sister at once, the disjunctive treatment of coordination becomes imperative (cf. Artstein 2002).

5. PRIOR ANALYSIS OF RELATIONAL PLURALS AND CONJOINED RELATIONAL NPS

We now discuss prior analyses of the relational plural NPs (Eschenbach 1993, Hackl 2002, Staroverov 2007) and conjoined relational nouns (Staroverov 2007). We argue that our analysis is preferable to other existing analyses both because it is simpler and because, unlike prior analyses, it unifies three seemingly disparate phenomena.

On the analysis of simple plural relational NPs due to Hackl 2002, the relational NP is pluralized for both argument slots at once by the ** operator (Krifka 1986, Beck 1999, 2000, 2001), as shown in (67). Reflexivization is achieved by saturating the internal argument slot by a silent pronoun coindexed with the subject.

(67) $**R(x)(y)=1$ iff
$R(x)(y)=1$ or
$\exists x_1, x_2, y_1, y_2\ [x_1 \oplus x_2 = x\ \&\ y_1 \oplus y_2 = y\ \&\ **R(x_1)(y_1)=1\ \&\ **R(x_2)(y_2)=1]$

As Staroverov 2007 points out, a doubly starred predicate is predicted to be cumulative (i.e., transitive), contrary to fact: e.g., by transitivity, the population of the whole city become *neighbors*, because each resident is a neighbor of some other resident (cf. Eschenbach 1993). Furthermore, the scopal interaction between the reflexive and pluralization, accounting for the ambiguity of *brothers and sisters*, becomes impossible to achieve.

On the analysis of Eschenbach 1993, the reciprocal meaning of a plural relational NP is derived from the singular meaning of that NP via the *rec* operator, whose definition is given in (68). The *rec* operator takes a transitive relation (such as the *sister* relation) as input, and returns a set of complex objects X, such that any two distinct parts of X are connected by the original relation. E.g., *sisters* then denotes a set of plural individuals X such that any part of X is a sister of every other part of X. Eschenbach's proposal therefore yields exactly the truth-conditions that we have arrived at. As discussed by Staroverov 2007, in her treatment, unlike in Hackl's, reciprocal plurals quantify over groups and are therefore not cumulative (i.e., reciprocal plurals are strongly reciprocal). Unfortunately, Eschenbach's analysis also cannot deal with the ambiguity of *brothers and sisters*.

(68) $rec = \lambda R \lambda X(ctbl(X) \wedge \forall z,w \leq X\ [at\ (z) \wedge at\ (w) \Rightarrow R(w)(z) \Leftrightarrow w \neq z])$

(69) a. $\forall x\ [cmplx\ (x) \Leftrightarrow ctbl\ (x) \wedge \neg\ at\ (x)]$ complex (= plural)
b. $\forall x\ [ctbl\ (x) \Leftrightarrow \forall c\ [c \leq x \Rightarrow \exists a\ [a \leq c \wedge at\ (a)]]]$ countable

In contrast with Eschenbach 1993 and Hackl 2002, Staroverov 2007 provides a unified analysis of both relational plurals and conjoined relational NPs. Staroverov 2007 derives the reciprocal interpretation of conjoined NPs (such as *husband and wife*) in three steps. First, the denotation of one of the conjoined NPs is inversed, using the *inv* operator given in (70a) (from Staroverov 2007, p. 305): for example, applied to the two-place relational noun *husband*, the *inv* operator returns, for any individual u, the set of individuals that u is a husband of. Application of *inv* now allows for the application of intersective conjunction schema (Winter 1995, 1996, 1998, 2001a) to *husband and wife*: while the intersective of the set of husbands and the set of wives is necessarily empty, the intersective of the inverse of the set of husbands with the set of wives may be non-empty. Application of *inv,* followed by intersective conjunction, yields (70b). The third step is application of a special collectivity operator ((70c)) that takes a relation and returns a pair of individuals connected by this relation, as in (70d); a stipulation is then needed to block the application of the collective operator to singular nouns.. Applied to *husband and wife*, this sequence of operations yields (70e), roughly paraphrased as "a pair of individuals x and y such that x is a husband of y and y is a wife of x" (Staroverov 2007, p. 306):

(70) a. $\text{inv}_{\langle\langle e,\langle e,t\rangle\rangle,\langle e,\langle e,t\rangle\rangle\rangle} = \lambda Y_{\langle e,\langle e,t\rangle\rangle} . \lambda u . \lambda v . Y(v)(u)$
b. $\lambda x.\lambda y\ [R_1(x)(y) \wedge R_2(y)(x)]$
c. $\lambda R_{\langle e,\langle e,t\rangle\rangle} . \lambda X . \exists y,z\ [X = y \oplus z\ \&\ R(y)(z)]$
d. $\lambda R \lambda Z \exists x \exists y [Z = x \oplus y \wedge R(x)(y)]$
e. $\lambda Z \exists x \exists y [Z = x \oplus y \wedge \text{husband'}(x)(y) \wedge \text{wife'}(y)(x)]$

Staroverov 2007 thus derives the interpretation of reciprocal conjunction from the intersective conjunction; he argues that this is a desirable result, since positing ambiguity between intersective *and* and reciprocal *and* would be redundant, given that the two are in most cases in complementary distribution (see also Artstein 2002).

Staroverov builds his analysis of relational plurals on that of conjoined relational nouns: with relational plurals, application of *inv* and of intersective conjunction is followed by application of the double star operator. The input to the double star operator is given in (71a). This correctly derives a weak reciprocal interpretation: e.g., for (71b) to be true, it is not necessary for every professor to have a student as a neighbor, or vice-versa. It is sufficient for two professor-student neighbor relations to be established for the relation p^{**} to be true.

(71) a. $p = \lambda x \lambda y (R(x)(y) \wedge \text{inv}(R(x)(y))$
b. In this city, the professors and the students are neighbors.

While Staroverov's analysis can capture the reciprocal interpretation of *a husband and wife*, it is not clear how this analysis would account for the fact that *two mothers and daughters* denotes four people, while *two brothers* denotes only two. Furthermore, we believe that our analysis is advantageous because it is simpler: Staroverov has to posit a sequence of operations, with the operation of *inv*, in particular, not independently motivated, where our analysis relies on independently motivated operations and lexical entries. Additionally, the analysis of Staroverov 2007 does not extend straightforwardly to conjoined non-relational NPs: for Staroverov, reciprocal readings are a subtype of intersective readings, and his analysis has nothing to say about additive readings. In contrast, our analysis derives both additive and intersective readings, with reciprocal readings a type of the former.

6. CONCLUSION

In this paper, we have advanced a unified analysis of three types of plural NPs: relational plurals, conjoined plurals, and conjoined relational plurals. Our analysis rests on several independently motivated elements: (1) the hypothesis that an NP which bears plural morphology can nevertheless be semantically singular (necessitated by the composition of complex cardinals, Ionin and Matushansky 2006); (2) the existence of pluralizing operators for the internal as well as external argument slots (cf. Krifka 1986); (3) a reflexive operator, necessitated by reflexive verbs; and (4) the analysis of non-Boolean conjunction from Winter 1996, 1998, 2001b. Elements (1) through (3) are used in our analysis of relational plurals, while elements (1) and (4), combined, allow us to analyze both singular and plural conjoined NPs. Putting together the analyses of relational plurals and of conjoined NPs, we obtain an analysis of conjoined relational NPs with no additional stipulations.

The final question to address is whether the analysis of reciprocal relational plurals, conjoined plurals and conjoined relational plurals advocated here is compatible with the standard semantics of cardinals, which treats them as intersective modifiers (Link 1987, Verkuyl 1997, Landman 2003). The answer is positive: to achieve the same interpretations, the standard analysis would need to only place the star operator just below the syntactic position of the cardinal in our analysis. We take this as an additional argument in favor of our treatment, since it shows that our analysis is not tied to one specific analysis of cardinals.

(72) a. $[\![\text{man and woman}]\!] = \text{man}_{\text{kind}} \oplus \text{woman}_{\text{kind}}$
b. $[\![\text{man and woman}]\!] = \lambda x.\ \text{man}(x) \vee \text{woman}(x)$
c. $[\![*]\!]\ ([\![\text{man and woman}]\!]) = \lambda x.\ [\text{man}(x) \vee \text{woman}(x)]$ or $\exists x_1,x_2[x_1 \oplus x_2 = x\ \&$

$*[\text{man}(x_1) \vee \text{woman}(x_1)]\ \&\ *[\text{man}(x_2) \vee \text{woman}(x_2)]]$

d. $⟦7⟧\ (⟦*⟧⟦\text{man and woman}⟧) = \lambda x.\ [\text{man}(x) \vee \text{woman}(x)]$ or $\exists x_1,x_2[x_1 \oplus x_2 = x\ \&\ *[\text{man}(x_1) \vee \text{woman}(x_1)]\ \&\ *[\text{man}(x_2) \vee \text{woman}(x_2)]]\ \&\ |x|=7$

From the syntactic point of view the analysis advanced above localizes number (NumP) relatively high in the extended projection of the NP, placing it higher than adjectives. We are not aware of any syntactic evidence for or against this proposal.

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