Ten men and women got married today

Lucas Champollion

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Comments welcome at `champollion@nyu.edu`

Abstract

The word *and* can be used both intersectively, as in *John lies and cheats*, and collectively, as in *John and Mary met*. Research has tried to determine which one of these two meanings is basic. Focusing on coordination of nouns (*liar and cheat*), this paper argues that the basic meaning of *and* is intersective. This theory has been successfully applied to coordination of other kinds of constituents (Partee & Rooth, 1983; Winter, 2001). Certain cases of noun coordination (*men and women*) challenge this view and have therefore been argued to favor the collective theory (Heycock & Zamparelli, 2005). The main result of this paper is that the intersective theory actually predicts the collective behavior of *and* in *men and women*. *And* leads to collectivity by interacting with silent operators involving set minimization and choice functions, which have been postulated to account for phenomena involving indefinites, collective predicates, and coordinations of noun phrases (Winter, 2001). This paper also shows that the collective theory does not generalize to coordinations of noun phrases in the way it has been previously suggested.

Keywords: coordination, plurality, collectivity, choice functions, type shifting, hydras

1 Introduction: How to deal with liars and cheats

The word *and* can be used both intersectively, as in the sentences in (1), and collectively, as in the sentences in (2). This paper focuses on conjunctive coordination of English nouns, where the same pattern can be observed. For example, sentences (1a) and (1b) both talk about a person in the intersection of the sets denoted by the predicates *liar* and *cheat*, while sentences (2a) and (2b) both talk about a collective entity formed by a male and a female person.

(1) a. John **lies and cheats**. *(intersective)*
b. That **liar and cheat** can not be trusted. *(intersective)*

(2) a. **John and Mary** met in the park last night. *(collective)*
b. A **man and woman** met in the park last night. *(collective)*

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Conjunction of plural nouns shows similar behavior, as the following examples illustrate (Heycock & Zamparelli, 2005). For example, sentence (3) is about two people, each of whom is both a friend and a colleague of mine, while sentence (4) is about a collective entity formed by a number of men and a number of women, and totaling ten.

(3) My two **friends and colleagues** wrote their paper together. *(intersective)*

(4) Ten **men and women** got married today in San Pietro. *(collective)*

In some cases, a given sentence can be ambiguous between an "intersective" and a "collective" reading. Heycock & Zamparelli call the former a joint and the latter a split reading. For example, sentence (5) below can either be understood as making a narrow claim about every linguist-philosopher – the joint reading – or as making a claim about every linguist and every philosopher – the split reading (Winter, 1998).

(5) Every **linguist and philosopher** knows the Gödel Theorem.
   a. Everyone who is both a linguist and a philosopher knows the Gödel Theorem.
   b. Every linguist knows the Gödel Theorem, and every philosopher knows the Gödel Theorem.

While in upward entailing contexts, the joint reading entails the split reading, in this case it is the opposite. This shows that the two readings are separate and that each needs to be treated in its own right.

A major theme in research on coordination has been the quest for a lexical entry that unifies these two uses of *and*. This amounts to determining whether the basic meaning of *and* is related to intersection, or whether it is related to formation of collective individuals. I will refer to the former view as the *intersective theory*. It is developed in several places (von Stechow, 1974; Gazdar, 1980; Partee & Rooth, 1983; Keenan & Faltz, 1985). As for the latter view, I will call it the *collective theory*. It is adopted, for example, by Krifka (1990a) and by Heycock & Zamparelli (2005). Some authors also assume that *and* is lexically ambiguous between an intersective and a collective use (e.g., Link, 1983, 1984; Hoeksema, 1988). I will call this the *ambiguity theory*.

Many authors refer to the intersective theory as *boolean conjunction* and to the collective theory as *non-boolean conjunction*, presumably because there is a close connection between intersection and the meet operation, particularly in boolean algebras (Keenan & Faltz, 1985). However, there are proposals in which *and* denotes a meet operation that is not limited to boolean models (e.g. Barker, 2010). Additionally, the collective theory is often couched in terms of classical extensional mereology, whose models are isomorphic to complete boolean algebras with the bottom element removed (Tarski, 1935; Pontow & Schubert, 2006; Champollion & Krifka, to appear). So the connection between the term pairs "boolean"/"non-boolean" and "intersective"/"collective" is not straightforward. For this reason, I will continue to call the first two theories "intersective" and "collective" rather than "boolean" and "non-boolean".

The third theory, which I have called the ambiguity theory, does not capture the intuitive connection between the intersective and collective uses. Furthermore, it does not capture the way these uses are tied together across languages. Typologically speaking, it is no accident that it is the English word "and", whose meaning includes intersection-based uses, which is used for collective formation, rather than the word "or", whose meaning can be described in terms of union. While many languages have coordinations that combine collective and intersection-based uses, no known languages have coordinations that combine collective and union-based uses (Payne, 1985). In other words, there are no known languages with a coordination that can be used to form collective individuals but that otherwise has the meaning of a disjunction. One of the goals of theories of coordination is to account for this generalization. The ambiguity theory is unable to provide such an account, because it does not predict that there should be a closer association between intersection and collective formation than between union and collective formation. This point is also argued in detail in Winter (2001).

So the only two options that remain are the intersective theory and the collective theory. Whichever one is adopted immediately accounts for one half of the empirical picture, and the challenge then consists in explaining the other half.

The purpose of this paper is to argue for the intersective theory, that is, for the view that *and* invariably denotes intersection. The main result of this paper is that the intersective theory actually predicts the collective behavior of *and*. It does this due to the way that the intersective meaning of *and* interacts with certain silent operators involving set minimization and choice functions. These operators are believed to be present in the grammar on the basis of phenomena involving indefinites and collective predicates, and they have been argued to cause collective interpretations in coordinations of noun phrases including generalized quantifiers (Winter, 2001). I will also show that the collective theory leads to problems when we try to adopt it to precisely the case in which the intersective theory has the fewest problems, namely coordination of generalized quantifiers.

The intersective theory immediately delivers the intersective behavior of *and*, as in (1). For example, the coordination in (1b) is a case of predicate intersection: the set denoted by *liar and cheat* is the intersection of the sets denoted by *liar* and by *cheat*. As for the collective behavior of coordination, as in (2)-(4), I will show that it emerges as a consequence of the interaction of *and* with a series of independently motivated silent operators. Although the focus of this paper is not on the distribution of these operators, the present proposal is compatible with the view that they are silent syntactic elements whose distribution is constrained by syntax, following Winter (2001). An alternative is to regard them as semantic composition rules akin to type shifters that are invisible to the syntactic component of the grammar. For an accessible discussion of the difference between the two perspectives and some putative psycholinguistic and neurolinguistic correlates, see Pylkkänen (2008).

In a nutshell, I will argue that coordinations like *man and woman* are interpreted collectively because the two nouns are interpreted in the same way as the two noun phrases that are conjoined in the coordinated noun phrase *a man and a woman*. This does not mean that, syntactically speaking, *man and woman* in (2b) is a noun phrase or a conjunction of noun phrases. (I use "noun phrase" to refer to what is called DP in theories like Abney (1987) and NP in other theories. In theories like Abney's, NP stands for nominals, that is, noun phrases without their determiners.) Rather, *man and woman* is a conjunction of nominals and is therefore itself a nominal. So even though at one point in the derivation of *man and woman*, it has the same meaning as *a man and a woman*, the two constituents have different syntactic status.

In order to do this, the paper proceeds as follows. For the purpose of exposition, I start in Section 2 with the case of coordination of singular nouns, as in *man and woman*. I introduce and then motivate the main silent operators of the paper, and show how to apply them to a coordination of two singular nouns denoting disjoint sets: *man and woman*. These silent operators shift each of these nouns to a generalized existential quantifier, intersect them, and eliminate non-minimal elements from the result. At this point the conjunction denotes the set of all man-woman pairs. When the two nouns denote non-disjoint sets, as in *doctor and lawyer*, the generalized-quantifier approach needs to be supplemented with a way to fix the two individuals independently of each other. This is done in Section 4, by means of choice functions. The next step in the development of the analysis, in Section 5, consists in accounting for the collective behavior of plural nouns, as in the title of this paper (*Ten men and women got married today*). The relationship between *and* and *or* on the present account is dealt with in Section 6, where the typological facts discussed above are also explained. Section 7 compares the current account with previous work. First, I focus on the implementation of the collective theory in Heycock & Zamparelli (2005). I show that in contrast to what Heycock & Zamparelli suggest, their implementation does not generalize to coordinations of noun phrases in the way they intend it to. Section 7 also discusses the account of Winter (1998), who gives a pair-forming denotation to *and*, in a similar way to alternative semantic treatments of *or* which have been developed since then. I summarize the main results of the paper in Section 8 and suggest avenues for further research.

2 Man and woman: the last obstacle to intersective coordination

This section presents the basic idea of the analysis in this paper. My general strategy consists in assuming that *and* has just one lexical entry, which is intersective. I derive the intersective/collective ambiguity from the optional presence of silent operators, rather than from a lexical ambiguity of *and*. On the view advocated here, all sentences with noun-noun coordination are in principle structurally ambiguous depending on whether or not they contain these silent operators, but this ambiguity only shows up in certain cases like the Gödel sentence in (5). In most cases, only one of the readings will surface, due to world knowledge and plausibility considerations. For example, sentences involving the coordination *man and woman* lack the intersective reading because nobody is both a man and a woman, apart from hermaphrodites. I will pretend that *man* and *woman* denote disjoint sets. This will simplify the presentation of the theory. Nouns that denote overlapping sets will be the topic of Section 4.

2.1 The meaning of *man and woman*

In this subsection I show that *man and woman* must be able to mean more or less the same thing as *man-woman pair* or *(heterosexual) couple*. I will do this by using the following sentence, which contains a relative clause headed by a coordinative construction, or in other words, a hydra.

(6) A man and woman who dated met in the park.

Hydras were first described, and named after the mythological multiple-headed creatures, by Link (1984). In (6), the relative clause *who dated* is a hydra because it is headed by the noun-noun coordination *man and woman*.

Relative clauses with subject extraction sites are synonymous with the predicates in them (for details and a theory that ensures this, see for example Heim & Kratzer (1998)):

(7) $[\![\text{who dated}]\!] = [\![\text{dated}]\!]$

Relative clauses in general are assumed to be intersective modifiers of their heads, and they are known to modify nominals (NPs) rather than noun phrases (DPs) (Partee, 1975). In this case, for example, the hydra *who dated* syntactically modifies the nominal *man and woman*, rather than *a man and woman*, which is not a constituent in this sentence. Given these assumptions, the semantics of the nominal in (6) must essentially be computed as follows:

(8) ⟦man and woman who dated⟧ = ⟦man and woman⟧ ∩ ⟦(who) dated⟧

The relative clause *who dated* denotes a collective predicate. So we know that its denotation must be a predicate of collective individuals, namely, couples who dated. From this and (8), it follows that the nominal *man and woman* also denotes a property of collective individuals. In other words, *man and woman* means roughly the same thing as *man-woman pair* or *(heterosexual) couple*. This is important, because as we will see, some theories fail to assign it this meaning.

A similar argument for the claim that *man and woman* denotes the property of being a man-woman pair can be made from noun phrases like the following, as observed by Heycock & Zamparelli (2005):

(9) a. that ill-matched man and woman ($\neq$ that ill-matched man and ill-matched woman)
b. that mutually incompatible man and woman ($\neq$ that mutually incompatible man and mutually incompatible woman)

I assume that any collection of individuals constitutes a plural entity (Link, 1983). In this paper, I represent plural entities as nonempty sets (e.g. Bennett, 1974; Winter, 2001). I represent the denotation of *man and woman* as the predicate that holds of any set consisting of a man and a woman:

(10) $[\![\text{man and woman}]\!] = \lambda P_{et} \exists x \exists y . \mathbf{man}(x) \wedge \mathbf{woman}(y) \wedge P = \{x, y\}$

From here on, I will abbreviate this collective predicate as **mw-pair** and I will refer to it as the set of couples.

At this point, you might think that the collective theory has a clear advantage, since it is easy in that theory to let *man and woman* denote the property **mw-pair**. For example, the following two lines implement the collective theory and deliver the meaning in (10) for *man and woman*.

(11) **Collective Formation**:
$[\![\text{and}_{coll}]\!] = \lambda P \lambda Q \lambda X . \exists y \exists z [P(y) \wedge Q(z) \wedge X = \{y\} \cup \{z\}]$

These two lines have the effect that a predicate P *and* Q holds of a collective entity X iff X consists of two (possibly identical) entities y and z, such that $P(y)$ and $Q(z)$ hold. For example, when this entry is applied to *man* and *woman*, it returns the set of all collective individuals consisting of a man and a woman. Indeed, Link (1984) applies a mereological equivalent of this entry to the hydra constructions he describes, such as the one in (6).

If noun-noun conjunction was the only kind of conjunction we have to model, we could stop here and adopt the collective theory. Instead, in the rest of this section I develop and motivate the intersective theory, in part because I want to show that it can be done even for cases like *man and woman*, and in part because the collective theory comes with its own problems. The case against the collective theory is based on conjunctions of noun phrases, and it is laid out in a later part of the paper, Section 7.

2.2 How to derive the meaning of *man and woman*

In this subsection, I show that it is possible to derive the set **mw-pair** as the meaning of *man and woman* while assuming that *and* denotes intersection. This might perhaps be surprising.

After all, the intersection of the set of men and the set of women is empty. So I will let go of the implicit assumption that it is these sets that are intersected.

There are three steps to the account I will present. I call them *Raising*, *Intersection*, and *Minimization*. In the first step, *Raising*, we convert the set of men into the set of all the sets that contain a man (and possibly other entities). We do the same thing with the set of women and obtain the set of all the sets that contain a woman (and possibly other entities). The type of the output of this step is higher than the type of its input, and that is why I call it *Raising*. In the second step, *Intersection*, we intersect the two sets that Raising gave us. This yields the set of all those sets that contain both a man and a woman, and possibly other entities. There are a lot of such sets. Some of them are very big, for example the set of all Britons. Others are smaller, for example the set that consists of the three Britons Churchill, Blair, and Thatcher, or the set that consists only of Churchill and Thatcher. The third and last step, *Minimization*, goes through the list of all these sets and removes all those that have a subset already on the list. So we remove the set of all Britons, and the set that consists of Churchill, Blair, and Thatcher, because both of them have the set of Churchill and Thatcher as one of their subsets, and that set is already on the list. When we are done, we return the set of all those sets that are still on the list. Each of these sets contains just two individuals: a man and a woman. This is the set I have called **mw-pair**.

I will now lay out in a bit more detail the account I just sketched. In the next subsection I will provide independent motivation for each of the three steps by pointing out other semantic domains where they also show up. Some of these domains involve conjunction of constituents other than nouns, and others involve phenomena that are completely unrelated to conjunction.

The first step, *Raising*, can be implemented in different ways. One way is the following: when applied to the set of men, generate the set of all the sets whose intersection with the set of men is nonempty. I will call this *Existential Raising*, since one can find out if an intersection is nonempty by checking if there exists an entity in it. Another way to implement *Raising* is as follows: When applied to the set of men, choose one of them according to a predetermined way of choosing men, and generate the set of all the sets that contain him. I will call this *Choice Raising*. This "way of choosing men" can be thought of as a choice function, that is, a function that maps any nonempty set to one of its elements. Choice functions have long played an important role in semantic accounts of indefinites (e.g. Reinhart, 1997; Winter, 1997).

Existential Raising and Choice Raising will sometimes lead to different results, and this will be important later on. Existential Raising gives us the set of all sets that contain some man or other, possibly different men for different sets. Choice Raising asks us to choose a man and then gives us all the sets that contain the man we have chosen. It turns out that for simple sentences the difference between the two implementations is immaterial, and for presentational purposes I will first use Existential Raising, since it is simpler. The following operator implements Existential Raising. It corresponds to the treatment of *a/an* in Montague (1973b), which inspired the operator A in Partee (1987), called E in Winter (2001). I will call it ER. Choice Raising can be thought of as a generalization of ER, and I will come back to it in Section 4.1. In the following definition, τ is a variable that ranges over arbitrary types, but it is useful to think of it as the type e of individuals for now.

(12) **Existential raising:**
$$[\![\text{ER}]\!] = \lambda P_{\tau t} \lambda Q_{\tau t}.\ \exists x_\tau . x \in P \cap Q$$

When existential raising is applied to the set of men, it returns (the characteristic function of) the set of all sets that contain some man or other:

(13) $[\![\text{ER(man)}]\!] = \lambda P.\exists x.\textbf{man}(x) \wedge P(x)$

The second step, *Intersection*, is at the heart of the intersective theory of conjunction (e.g. Partee & Rooth, 1983). I will call it INT. The following formulation of Intersection makes its connection with conjunction clear. Again, think of τ as the type e of individuals.

(14) **Intersection:**
$[\![\text{INT}]\!] = \lambda P_{\tau t}\lambda Q_{\tau t}\lambda x_\tau.x \in P \wedge x \in Q$

As long as we allow ourselves to switch freely back and forth between functions and their characteristic sets, Intersection can be given the following equivalent alternative formulation, which shows its connection to set-theoretic intersection more clearly:

(15) **Intersection (alternative formulation):**
$[\![\text{INT}]\!] = \lambda P_{\tau t}\lambda Q_{\tau t}.P \cap Q$

The intersective theory of coordination can then be stated simply as follows:

(16) **Intersective theory of *and***:
$[\![\text{and}]\!] = [\![\text{INT}]\!]$

This is a simplified view on the intersective theory. It only works for categories of type τt, where τ is any type. It can, however, be generalized to arbitrary conjoinable types (that is, types that "end in t") as in the recursive definition (17), from which (16) can be shown to follow as a special case. These types are sometimes called conjoinable or boolean types. For details on this approach, see for example Partee & Rooth (1983).

(17) $$[\![\text{and}]\!]_{\langle\tau,\tau\tau\rangle} = \begin{cases} \wedge_{\langle t,tt\rangle} & \text{if } \tau = t \\ \lambda X_\tau\lambda Y_\tau\lambda Z_{\sigma_1}.X(Z)\ [\![\text{and}]\!]_{\langle\sigma_2,\sigma_2\sigma_2\rangle}\ Y(Z) & \text{if } \tau = \langle\sigma_1,\sigma_2\rangle \end{cases}$$

When we use Intersection in order to combine the denotation of *ER(man)* with that of *ER(woman)*, we get the set of all those sets that contain both a man and a woman. This is shown here:

(18) $[\![\text{ER(man) and ER(woman)}]\!]$
a. $= [\![\text{INT(ER(man))(ER(woman))}]\!]$
b. $= [\lambda P.\exists x.\textbf{man}(x) \wedge P(x)] \cup [\lambda P.\exists y.\textbf{woman}(y) \wedge P(y)]$
c. $= \lambda P.\exists x\exists y.\textbf{man}(x) \wedge \textbf{woman}(y) \wedge P(x) \wedge P(y)$

While every set in (18c) contains a man and a woman, most of these sets also contain many other entities. However, the sets we are interested in are precisely the minimal sets in (18c). The third and final step, *Minimization*, is what gives us these sets (Winter, 2001). Here as before, it is useful to think of τ as the type e of individuals.

(19) **Minimization:**
$[\![\text{MIN}]\!] = \lambda Q_{\langle\tau t,t\rangle}\lambda P_{\tau t}.\ P \in Q \wedge \forall P' \in Q[P' \subseteq P \rightarrow P' = P]$

In general, we can distill any set into the set of its minimal subsets by the Minimization operator. It is useful to realize that although Minimization can be used to map predicates of type $\langle et,t\rangle$ to other predicates of type $\langle et,t\rangle$, the two kinds of predicates differ conceptually. The former are best thought of as generalized quantifiers, and the latter are best thought of as predicates of collective indidivuals. This "predicate-quantifier flexibility" is one of the central themes in Winter (2001).

Now, when we apply Minimization to the set in (18c), we get the set that contains all those sets that consist of just a man and a woman and nothing more than that:

(20) ⟦MIN(ER(man) and ER(woman))⟧

a. = ⟦MIN⟧$(\lambda P.\exists x \exists y.\textbf{man}(x) \wedge \textbf{woman}(y) \wedge P(x) \wedge P(y))$

b. = $\lambda Q_{\langle et,t\rangle} \lambda P_{et}.P \in Q \wedge \forall P' \in Q[P' \subseteq P \rightarrow P' = P](\lambda P.\exists x \exists y.\textbf{man}(x) \wedge \textbf{woman}(y) \wedge P(x) \wedge P(y))$

c. = $\lambda P_{et}.P \in (\lambda P.\exists x \exists y.\textbf{man}(x) \wedge \textbf{woman}(y) \wedge P(x) \wedge P(y)) \wedge \forall P'.[P' \in (\lambda P.\exists x \exists y.\textbf{man}(x) \wedge \textbf{woman}(y) \wedge P(x) \wedge P(y)) \wedge P' \subseteq P] \rightarrow P' = P$

d. = $\lambda P_{et}.\exists x \exists y.\textbf{man}(x) \wedge \textbf{woman}(y) \wedge P(x) \wedge P(y) \wedge \forall P'.[\exists x \exists y.\textbf{man}(x) \wedge \textbf{woman}(y) \wedge P'(x) \wedge P'(y)) \wedge P' \subseteq P] \rightarrow P' = P$

e. = $\lambda P.\exists x \exists y.\textbf{man}(x) \wedge \textbf{woman}(y) \wedge P = \{x, y\}$

This is the same set as the one in (10), which was what I called **mw-pair**. So we have now successfully derived the meaning of *man and woman*.

2.3 How to use the meaning of *man and woman* in context

In this subsection I show how to use the predicate denoted by *man and woman* in context. Specifically, we will look at two simple derivations. One of them involves collective predication, and the other one involves distributive predication. There will be nothing special in the way *man and woman* is used in these derivations. This is as it should be, because *man and woman* can essentially be used in the same places and with more or less the same meaning as expressions like *man-woman pair* or *couple*. So the way in which any one of these expressions is used should correspond to the way the other ones are used.

First let us analyze the hydra in (6), repeated here as (21).

(21) A man and woman who dated met in the park.

Since I have represented collective individuals as sets, I assume that the collective predicates *dated* and *met (in the park)* are represented as properties of sets (Winter, 2001):

(22) a. ⟦dated⟧ = $\lambda P_{\langle et\rangle}.\textbf{date}(P)$

b. ⟦met (in the park)⟧ = $\lambda P_{\langle et\rangle}.\textbf{meet}(P)$

As already mentioned above, I assume that *who dated* means the same thing as *dated*, and that relative clauses are intersective modifiers of their heads. I will also assume, for convenience, that the determiner *a* denotes a generalized quantifier over sets of arbitrary types, so that it can deal with collective predicates. In other words, *a* denotes the same as Existential Raising. A more detailed theory of how determiners interact with collective predicates can be found in Section 6 and in Winter (2001). It would do just fine here, but I stick to the simpler one in order to keep the discussion easy to follow.

(23) $[\![\text{a}]\!] = \lambda P_{\tau t} \lambda Q_{\tau t}.\ \exists x_\tau.x \in P \cap Q$

We can now put all these assumptions to work and derive a meaning for the hydra:

(24) ⟦a(MIN(ER(man) and ER(woman)) who dated)(met)⟧

a. = ⟦a⟧(⟦(20e)⟧ ∩ ⟦dated⟧)(⟦met⟧)

b. = ⟦a⟧$(\lambda P.\exists x \exists y.\textbf{man}(x) \wedge \textbf{woman}(y) \wedge P = \{x, y\} \wedge \textbf{date}(\{x, y\}))(\textbf{meet})$

c. $= \exists P \exists x \exists y.\textbf{man}(x) \wedge \textbf{woman}(y) \wedge P = \{x,y\} \wedge \textbf{date}(\{x,y\}) \wedge \textbf{meet}(\{x,y\})$
d. $= \exists x \exists y.\textbf{man}(x) \wedge \textbf{woman}(y) \wedge \textbf{date}(\{x,y\}) \wedge \textbf{meet}(\{x,y\})$

This is true if and only if there is a set consisting of a man and a woman, and nothing else, and that set is in the denotations of *dated* and of *met*. These are the right truth conditions.

At this point, we have seen how to derive the meaning of the nominal *man and woman* and how to use it in a sentence that involves collective predication. Now let us see how it can be used in a sentence that involves distributive predication, such as the following:

(25) A man and woman had a beer.

On its distributive interpretation, sentence (25) entails the following:

(26) A man had a beer and a woman had a beer.

This suggests that the predicate *had a beer* applies separately to the man in question and to the woman in question. It is common to assume that this is due to a silent distributivity operator that can be paraphrased as "each" and that shifts a predicate like *have a beer* into its distributive interpretation (e.g. Link, 1991). I will refer to this operator as *Predicate Distributivity* and I will call it PDIST. In the present setup, where pluralities are modeled as sets, this operator can be thought of as powerset formation, except that we do not need to keep the empty set around so we will remove it (Winter, 2001). Predicate Distributivity can be represented as follows:

(27) **Predicate Distributivity:** (Winter, 2001)
$[\![\text{PDIST}]\!] = \lambda P'_{et} \lambda P_{et}.P \neq \emptyset \wedge P \subseteq P'$

For example, the verb phrase *have a beer* can be shifted as follows:

(28) a. $[\![\text{have a beer}]\!] = \lambda x.\exists y.\textbf{beer}(y) \wedge \textbf{have}(x,y)$
b. $[\![\text{PDIST(have a beer)}]\!] = \lambda P_{et}.P \neq \emptyset \wedge P \subseteq \lambda y[\textbf{beer}(y) \wedge \textbf{have}(x,y)]$

This shifted predicate holds of a set just in case it is nonempty and each of its members had a beer. This predicate can now be combined with *man and woman* as above:

(29) $[\![\text{a(MIN(ER(man) and ER(woman)))(PDIST(had a beer))}]\!]$
a. $= [\![\text{a}]\!]([\![\text{(20e)}]\!])([\![\text{PDIST}]\!]([\![\text{had a beer}]\!]))$
b. $= [\![\text{a}]\!](\lambda P.\exists x \exists y.\textbf{man}(x) \wedge \textbf{woman}(y) \wedge P = \{x,y\})(\lambda P'_{et} \lambda P_{et}.P \neq \emptyset \wedge P \subseteq P'([\![\text{had a beer}]\!]))$
c. $= [\![\text{a}]\!](\lambda P.\exists x \exists y.\textbf{man}(x) \wedge \textbf{woman}(y) \wedge P = \{x,y\})(\lambda P_{et}.P \neq \emptyset \wedge P \subseteq [\![\text{had a beer}]\!])$
d. $= \exists P \exists x \exists y.\textbf{man}(x) \wedge \textbf{woman}(y) \wedge P = \{x,y\} \wedge P \neq \emptyset \wedge P \subseteq [\![\text{had a beer}]\!]$
e. $= \exists x \exists y.\textbf{man}(x) \wedge \textbf{woman}(y) \wedge \{x,y\} \subseteq \lambda x'.\exists z.\textbf{beer}(z) \wedge \textbf{have}(x',z)$
f. $= \exists x \exists y.\textbf{man}(x) \wedge \textbf{woman}(y) \wedge \exists z.\textbf{beer}(z) \wedge \textbf{have}(x,z) \wedge \exists z.\textbf{beer}(z) \wedge \textbf{have}(y,z)$

These truth conditions can be paraphrased as "There are a man and a woman who each had a beer." This is what we want.

To summarize this section, I have argued in Section 2.1 that *man and woman* denotes the set of all sets that consist of a man and a woman. Section 2.2 has shown that this set can be derived despite adopting the intersective theory of *and*, via the three operations Raising, Intersection, and Minimization. Raising converts *man* and *woman* to existential quantifiers, Intersection combines them in a way that conforms to the intersective theory of *and*, and Minimization returns the set of all sets that consist of a man and a woman. In Section 2.3 I have shown how to use this meaning in connection with collective predicates and with distributive predicates. All of this came at a price: I have used silent operators that would not be needed on the collective theory. As I have discussed at the end of Section 2.1, the collective theory does not rely on the ER or MIN operators. The next section therefore provides evidence for these silent operators.

3 Justifying the silent operators

This section offers motivation for the assumption that the interpretive process contains the three operators *Raising* (ER), *Intersection* (INT), and *Minimization* (MIN) that I have introduced in Section 2. In each case, the evidence I offer is independent from noun-noun coordination. As stated before, I take ER and MIN to be silent, and I take INT to be the meaning of *and*. (I have introduced one more operator, PDIST. This operator does not need to be justified, because so far it occurs only outside of coordination constructions, and so it is needed no matter whether one adopts the intersective or the collective theory.)

3.1 Evidence for Raising

In this subsection I review the evidence for the presence of the Existential Raising operator in the grammar. The definition of this operator is repeated here:

(30) **Existential Raising:**
$[\![\text{ER}]\!] = \lambda P_{\tau t} \lambda Q_{\tau t}.\ \exists x_\tau . x \in P \cap Q$

The idea of a silent operator that lifts its restrictor into an existential quantifier has a long tradition. There are many places in which Existential Raising or a similar operation has been claimed to be at work.

First, the existential interpretation of bare plurals, as in *Dogs are barking outside right now*, is often analyzed as the result of a type shifter that is similar to Existential Raising. The basic idea is that in such sentences, the bare plural *dogs* is not interpreted as a predicate that holds of pluralities of dogs, butas the generalized quantifier *some dogs*, where *some* is silent and corresponds to Existential Raising. Examples of analyses that use such type shifters include Carpenter (1997, ch. 8) and Krifka (2004). A related and influential analysis is Chierchia (1998). This system uses a special operation called *Derived Kind Predication* which combines a shift from kinds to properties with a Raising-like operation on these properties. So this operation is somewhat more involved than Existential Raising. For a useful overview of what Chierchia's and Krifka's accounts have in common (including Existential Raising) and how they differ, see Cohen (2007).

Second, as I have mentioned before, Existential Raising is the meaning that is traditionally assigned to the English indefinite article *a* (Montague, 1973a; Barwise & Cooper, 1981). From that point of view, languages that do not pronounce the indefinite article, such as Hebrew, can be argued to provide motivation for a silent version of Existential Raising (Winter, 2001, p. 138).

Third, indefinite noun phrases in English can form intersective conjunctions with adjective phrases (31a). On the intersective theory of *and*, it is often assumed that only constituents of the same type can be conjoined. This assumption was explicitly encoded in (17). On that basis, given that adjective phrases like *competent in semantics* denote predicates, so do indefinite noun phrases like *an authority on unicorns*. But when indefinite noun phrases are used in argument positions as in (31b), they are often assumed to denote generalized quantifiers. For this reason it has been suggested that indefinite noun phrases can be shifted from predicate to quantifier type using Existential Raising (Partee, 1987).

(31) a. Mary considers John competent in semantics and an authority on unicorns.
b. An authority on unicorns walked in.

Fourth, noun phrases like *three boys* are often analyzed as predicates of pluralities, since this explains their ability to license collective readings and to occur in predicative positions (e.g. Verkuyl, 1981; Link, 1987). But in argument position, such noun phrases are often assumed to be interepreted as generalized quantifiers (Barwise & Cooper, 1981). The gap between these two kinds of theories is often bridged by assuming that the predicative meaning can be mapped to its generalized quantifier meaning by a silent determiner or other operation whose meaning amounts to Existential Raising. More recently, this line of analysis has even been extended to modified numerals like *exactly three boys* (Krifka, 1999; Landman, 2004; Brasoveanu, 2013). I will also adopt this predicative analysis in this paper, but it will not become relevant until I talk about plural nouns in Section 5.2.

Fifth, predicates that result from conjoining indefinites in predicative position can result in joint (intersective) as well as in split (collective) interpretations. For example, (32a) can be considered to have a joint interpretation and (32b), a split one.

(32) a. Mary is an author and a teacher.
b. These two women are an author and a teacher.

The split interpretation of *an author and a teacher* has been argued to result from a category shifting principle that corresponds to Raising and that turns predicates into quantifiers (Winter, 2001, ch. 4). The analysis in question is very similar to the present one. The predicates *an author* and *a teacher* are both mapped to generalized quantifiers via Raising. These generalized quantifiers are then combined via Intersection.

Lastly, in order to adequately capture the interaction of Neo-Davidsonian event semantics with verb phrase conjunction as well as with quantification and negation, the basic denotations of verbs should be shifted from event predicates to existential quantifiers before anything else happens to them, as I have argued elsewhere (Champollion, 2014). The process by which this is done can be thought of as an application of Existential Raising to the lexical entry of each verb.

In Section 4.1, I provide more evidence for Raising. As I point out there, one can think of it as a generalization of choice-functional operators, which have been used to account for the exceptional scope properties of indefinites (Reinhart, 1997). Because choice-functional operators are generally taken to apply to nouns, it is a natural assumption that Raising applies to nouns as well, as I am doing here. My formulation of Existential Raising does not make the choice functions explicit. At this preliminary stage in the analysis, this does not matter. Later on, I will generalize Existential Raising to Choice Raising. That implementation contains an explicit choice function variable, which can be bound at a higher place than it is introduced. Winter develops his analysis in a similar way and talks about the *E/CF mechanism*, where E is Existential Raising, and CF stands for choice function (Winter, 2001).

3.2 Evidence for Intersection

In this subsection, I briefly review evidence for my assumption that intersection is an accurate representation of the meaning of *and* in cases other than noun-noun coordination. My assumption embodies the intersective theory of *and*, which has been proposed in a number of places, as mentioned before (von Stechow, 1974; Gazdar, 1980; Partee & Rooth, 1983; Winter, 2001).

The intersective theory of *and*, slightly simplified for the present purpose, is repeated here:

(33) **Intersection:**
$[\![\text{and}]\!] = \lambda P_{\tau t} \lambda Q_{\tau t} \lambda x_{\tau} . x \in P \wedge x \in Q$

The intersective theory assumes that *and* always combines with two constituents and intersects them in some way. In the case of sentential coordination, if one adopts an extensional framework as I do it here, one way to do this is to identify falsity with the empty set, and truth with some other set S, as in von Neumann arithmetic. Then conjunction of truth values can be modeled as intersection (Gazdar, 1980). That is, the conjunction of a true and a false sentence amounts to intersecting S with the empty set, and this gives us the empty set. The conjunction of two true sentences amounts to intersecting S with itself, and this gives us S. And conjoining two false sentences amounts to intersecting the empty set with itself, which gives us the empty set.

The intersective theory of conjunction also works well in the case of conjunction of verb phrases, assuming they denote properties of individuals. For example, in the absence of any of the operators I have discussed, it predicts that *sang and danced* denotes the intersection of the set of singers with the set of dancers. Assume that noun phrases are interpreted as generalized quantifiers in the style of Montague (1973a) and Barwise & Cooper (1981). Then the two sentences in (34) are correctly predicted to be equivalent when noun phrases like *every woman, Mary,* or *John and Mary* are inserted, and to be nonequivalent when noun phrases like *some woman, no woman, Mary or John, neither Mary nor John, exactly one woman* and so on are inserted. For more details, see for example (Winter, 2001, p. 9).

(34) a. DP sang and danced.
b. DP sang and DP danced.

One of the noun phrases I mentioned, *John and Mary*, involves conjunction of noun phrases. So I should mention how they are treated on the intersective theory. If proper names are taken to denote ordinary individuals, they cannot be intersected unless we first shift them to another type. One way to do this is the operator LIFT defined in (35). This operator is sometimes called the "Montague Lift". It maps an individual to the set of all the sets that contain this individual (e.g. Montague, 1970; Partee & Rooth, 1983). Such sets can then be intersected. For example, *John and Mary* ends up denoting the set of all those sets that contain both John and Mary.

(35) **Montague Lift:**
$[\![\text{LIFT}]\!] = \lambda x_e \lambda P_{\langle et \rangle} . P(x)$

Evidence for LIFT comes from the ability to conjoin quantificational and nonquantificational noun phrases, as in *John and every woman*, again on the assumption that *and* can only conjoin categories of the same type (Keenan & Faltz, 1985).

To sum up this subsection, one of the strengths of the intersective theory of *and* is its interaction with the generalized quantifier theory of Barwise & Cooper (1981). This fact has been recognized for a long time, but it is worth pointing it out here because, as we will see in Section 7.1, interaction with generalized quantifiers is one of the greatest challenges for the collective theory of *and*.

3.3 Evidence for Minimization

In this subsection, I provide evidence for the operator I have called *Minimization*, repeated here:

(36) **Minimization:**
$[\![\text{MIN}]\!] = \lambda Q_{\langle \tau t,t\rangle} \lambda P_{\tau t}.\ P \in Q \wedge \forall P' \in Q[P' \subseteq P \rightarrow P' = P]$

The intersective theory faces a challenge when it comes to modeling the collectivity effect in sentences like (37), repeated here from (2a):

(37) John and Mary met in the park last night.

This is because the conjunction of the generalized quantifiers that are obtained by Montague-lifting the two constants corresponding to *John* and *Mary* is the predicate $\lambda P.P(j) \cap \lambda P.P(m)$. Expressed in terms of sets, this corresponds to the following set:

(38) $[\![\text{John and Mary}]\!] = \{P \mid j \in P\} \cap \{P \mid m \in P\}$

Let us refer to subsets of the domain as properties. Then this set contains all properties P such that P holds both of John and of Mary. The problem is that the property denoted by *met in the park last night* does not hold of John, nor of Mary: It is a collective predicate. Otherwise, (37) would entail that John met in the park last night and that Mary did too.

An extension of the intersective theory of *and* to such cases is proposed by Winter (2001). This extension relies on the insight that one can use the Minimization operator to "distill" any intersection or union of the Montague lifts of some individuals into a set of sets of these individuals. The result of applying Minimization to the set in (38) is the set $\{\{j, m\}\}$, a singleton set whose only member is a two-element set. We can now view this set as the property of being the collective individual consisting of John and Mary.

The other property involved in sentence (37) is denoted by the verb phrase. This property holds of any set S just in case S met in the park last night. The meaning of (37) can then be obtained by combining these two properties via Existential Raising, in a similar way to the silent determiners I discussed in Section 3.1.

Given these assumptions, Winter analyses the subject of sentence (37) as in (39), a property which is true of any set that contains the collective individual consisting of John and Mary. This gives the right truth conditions once it combines with the verb phrase. The sentence is predicted to be true just in case the set consisting of John and Mary is in the extension of the predicate *meet in the park last night*. Winter's derivation is as follows (I abbreviate the verb phrase as *meet*):

(39) $[\![\text{ER(MIN(LIFT(john) and LIFT(mary)))(met)}]\!]$

a. $= [\![\text{ER}]\!]([\![\text{MIN}]\!](\lambda P.P(j) \cap \lambda P.P(m)))(\textbf{meet})$
b. $= [\![\text{ER}]\!]([\![\text{MIN}]\!](\lambda P.P(j) \wedge P(m)))(\textbf{meet})$
c. $= [\![\text{ER}]\!](\{\{j, m\}\})(\textbf{meet})$
d. $= (\lambda C'_{\langle et,t\rangle} \lambda C_{\langle et,t\rangle}.\ \exists X_{et}.X \in C \wedge X \in C')(\{\{j, m\}\})(\textbf{meet})$
e. $= (\lambda C_{\langle et,t\rangle}.\{j, m\} \in C)\ \ (\textbf{meet})$
f. $= \{j, m\} \in \textbf{meet}$

To sum up this section, both for Raising and for Minimization we can find evidence outside of noun-noun coordination. Raising corresponds, among other things, to silent determiners used to map predicative noun phrases to quantificational denotations. Minimization corresponds to the way quantificational noun phrases are mapped to predicative denotations. As for Intersection, it embodies the intersective theory of *and*, for which there is evidence involving sentential coordination and verb phrase coordination. Specifically, it predicts how these coordinations interact with nondistributive generalized quantifiers. The theory I have laid out in Section 2 uses familiar elements that have each been used in a variety of contexts, both within the domain of coordination and outside of it. It recombines these elements in a new way and does not require us to add any new silent operators to the picture.

4 Lawyers, doctors, and other overlappers

In the two previous sections, I have chosen the two nouns *man* and *woman* to illustrate the basic framework because they denote disjoint sets (hermaphrodites aside). This made it easier to present the system. But in the general case, of course we cannot rely on the two nouns being disjoint. This section extends the strategy consisting of Raising, Intersection, and Minimization to conjunctions of overlapping nouns, such as *doctor and lawyer*. To do so, I will replace Existential Raising by its close relative, Choice Raising.

Section 4.1 shows that overlapping nouns cannot be dealt with by Existential Raising alone, and draws a parallel to an analogous problem known to occur in conjunctions of noun phrases like *John and some man*. Section 4.2 reviews and adapts the choice-function based solution of that problem in Winter (2001). Section 4.3 extends that solution to conjunctions of nouns. Section 4.4 shows that the scope of the operators that bind these choice functions needs to be constrained in ways that are familiar from the relevant literature.

4.1 Overlapping nouns and overlapping noun phrases

I start by considering the case of sets that overlap but that do not completely coincide. Assume for example that some but not all doctors are lawyers, and that some but not all lawyers are doctors. For simplicity, let us say that these are the only two professions. Consider now the following sentence:

(40) A doctor and lawyer met.

Sentence (40) is true just in case someone who is a doctor met someone else who is a lawyer. When we hear (40), we are not in a position to conclude from (40) that either one of these two people has only one job. For all we know it might be that the first-mentioned one is not only a doctor but also a lawyer, or that the other one is not only a lawyer but also a doctor.

The derivations we have seen so far do not account for this. Applying Minimization to the intersection of ER(doctor) and ER(lawyer) returns the set of all sets S with the following three properties: (i) S contains a doctor d; (ii) S contains a lawyer (who may be distinct from d or identical to d); and (iii) has no proper subset that contains a lawyer and a doctor. Condition (iii) is the contribution of Minimization. Its effect in this case is that there will be two different kinds of sets S: singleton sets containing a doctor-lawyer, and two-element sets that contain a single-profession doctor and a single-profession lawyer. This is a problem, because it predicts that (40) is only true if each of the two people in question belong to only one profession.

In the extreme case where the two professions coincide, we have $[\![\text{doctor}]\!] = [\![\text{lawyer}]\!]$, and Minimization returns a set of singletons. This is even worse than the previous case, because (40) is now predicted to be deviant for the same reason that (41) is: a single individual cannot meet itself.

(41) #John met.

This kind of problem not only occurs in conjunctions of nouns but also in conjunctions of noun phrases (Winter, 2001). Imagine that John is a man, and that *some man* is modeled as a generalized quantifier. Then sentence (42) is wrongly predicted to be deviant.

(42) John and some man met.

The reason is that the singleton set of John fulfills the following conditions: (i) it contains John, and (ii) there is a man that it contains (namely John). Since this set is a subset of any other set that contains John and some man, Minimization eliminates all these other sets from the denotation of the conjoined noun phrase.

One can think of different ways to solve these problems. For example, one could exploit the fact that indefinites generally come with a novelty condition (Heim, 1982). This novelty condition is particularly strong when two indefinites are conjoined. For example, the following sentence cannot be true merely in virtue of a single male student who smiled:

(43) A man and a student smiled.

An implementation of this novelty condition could proceed by enriching the system with a dynamic component. I will take another route, however, which involves the use of choice functions, following Winter (2001). My adoption of choice functions is in part due to practical considerations. Since I am importing many assumptions and operators from Winter's framework, it is easier to also import his choice functions than to merge it with a dynamic account. Another reason for my choice is the fact that Winter argues for two choice function operators, a nondistributive and a distributive one. Each one of them will play an important role in the following development. In this section, I will use the nondistributive operator to solve the problem of overlap. In the next section, I will use the distributive operator to extend my account from conjunction of singular nouns conjunction of plural nouns.

4.2 How to deal with overlapping noun phrases

This subsection describes my adaptation of the solution to the problem of overlapping noun phrases offered in Winter (2001). That solution is based on the assumption that *some man* does not, in fact, denote a generalized quantifier. He assumes instead that indefinite determiners like *some* involve a variable whose value is a choice function, and that this choice function is applied to the complement of *some*, such as the set of men. For example, in (42), the set of men is mapped to a man. Winter then assumes that this man is Montague-lifted in order for *and* to be able to intersect it with the Montague lift of John. Thus for Winter, indefinites are hybrids of a generalized quantifier and a choice function variable. To interpret the noun phrase in (42), then, we pick a man, Montague-lift him to his generalized quantifier, intersect it with the Montague lift of John, send the result through Minimization, and finally existentially quantify over how we picked him by binding the choice-function variable. In effect, Winter splits Raising into two components: a choice function variable that applies to the complement, and a silent operator that binds that variable by an existential quantifier higher up in the tree. I will follow suit. In order to distinguish this new way of implementing Raising from what I have called Existential Raising above, I will call it Choice Raising.

Here is an implementation of Choice Raising in the well-known framework of Heim & Kratzer (1998). (Winter himself uses variable-free semantics in the style of Jacobson (1999). The choice between the two frameworks is not essential.) First consider the determiner *some*.

I will define Choice Raising by analogy immediately afterwards. The choice-functional treatment of *some*, and correspondingly of Raising, consists of two components, one that introduces a choice function variable and another one that existentially binds it. I discuss the two components in turn.

The first component corresponds to the word *some* itself. We assume that every occurrence of *some* is indexed with a distinct natural number i. We also assume that the interpretation function is equipped with a variable assignment g, which maps the index of a given occurrence *some*$_i$ to a choice function of type $\langle et, e\rangle$. We set the interpretation of *some*$_i$ given g, written $[\![\text{some}_i]\!]^g$, as in (44). An explanation follows below.

(44) $[\![\text{some}_i]\!]^g = \lambda N_{\langle et\rangle} : N \neq \emptyset.\lambda P_{\langle et\rangle}.P(g(i)(N))$
where $g(i)$ is a choice function of type $\langle\langle e,t\rangle, e\rangle$

I set the interpretation of Choice Raising in the same way. For reference:

(45) **Choice Raising:** (Winter, 2001)
$[\![\text{CR}_i]\!]^g = \lambda N_{\langle et\rangle} : N \neq \emptyset.\lambda P_{\langle et\rangle}.P(g(i)(N))$
where $g(i)$ is a choice function of type $\langle\langle e,t\rangle, e\rangle$

In words, the interpretation of *some*$_i$ and of Choice Raising given a variable assignment g maps i to a partial function that expects a set of individuals N (typically a singular noun), and is defined whenever that set is nonempty. The restriction to nonempty sets is inherited from Winter's treatment of choice functions and is independently motivated there (Winter, 2001). When defined, that function asks the variable assignment g for the value of i, which is assumed to be a choice function, and lets that choice function choose an individual from the set N. It then returns that individual's Montague lift, that is, the set of all properties P which hold of that individual. For example, g might map i to the choice function that maps any set to the tallest individual in that set, and N might be the set containing Laurel (175cm) and Hardy (185cm). In that case $[\![\text{some}_i]\!]^g$ applied to N would return the set of all properties that Hardy has.

The second component introduces an existential quantifier that binds the operator just defined. I will refer to it as Choice Closure and I will write $\exists$ for it. I assume that for every existential quantifier, including $\exists$, that is inserted into the LF tree, an index node of type $\langle et, e\rangle$ is inserted right underneath it and is interpreted via the predicate abstraction rule in (46). I will represent this index node as an indexed λ symbol. This strategy goes back at least to Lewis (1970). Here I will adopt the textbook treatment known as predicate abstraction (Heim & Kratzer, 1998).

(46) **Predicate Abstraction:** (Heim & Kratzer, 1998)
$[\![[\lambda_i\ \alpha]]\!]^g = \lambda f.[\![\alpha]\!]^{g[i\to f]}$

The $\exists$ operator corresponds to the variable-free operator called "Existential Choice Closure" in Winter (2001, p. 131). For the general case I define it as follows:

(47) **Choice Closure:** (adapted from Winter, 2001)
$[\![\exists]\!] = \lambda A_{\langle\langle et,e\rangle,\langle\alpha_1\ldots\alpha_n t\rangle\rangle}\lambda P_{\alpha_1}\ldots\lambda P_{\alpha_n}\exists f.\text{CF}(f) \wedge A(f)(P_1)\ldots(P_n)$

Here, CF stands for the predicate that holds of any function f of type $\langle et, e\rangle$ iff it is a choice function, that is, iff for any nonempty set N of type et, we have $f(N) \in N$. The number n stands for the arity of the predicate to which predicate abstraction applies. In the case we are interested in, namely quantificational noun phrases like *John and some man*, we have $n = 1$

since they only expect one predicate (the verb phrase), which is of type $\langle et \rangle$. In that case, (47) simplifies as follows:

(48) **Choice Closure** (when it takes scope at a node of type $\langle et, t\rangle$):
$[\![\exists]\!] = \lambda A_{\langle\langle et,e\rangle,\langle et,t\rangle\rangle} \lambda P_{et} \exists f.\text{CF}(f) \wedge A(f)(P)$

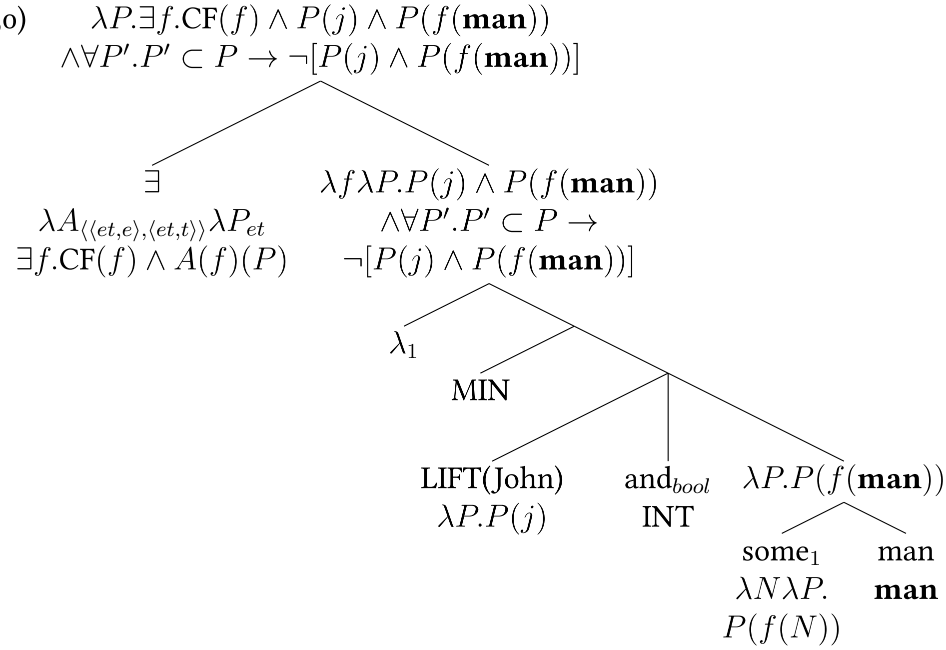
For completeness, here is a version of the operator that takes scope at a node of type t, at sentence level for example:

(49) **Choice Closure** (when it takes scope at a node of type t):
$[\![\exists]\!] = \lambda A_{\langle\langle et,e\rangle,t\rangle} \exists f.\text{CF}(f) \wedge A(f)$

When the first component of Choice Raising, the one defined in (44), occurs in the immediate scope of the predicate abstraction below Choice Closure, the net effect is the same as the Existential Raising operator defined in (12). This is because local existential quantification over individuals amounts to the same as local existential quantification over choice functions (Reinhart, 1997). For example, *Some dog barks* is true if and only if there exists a dog that barks, or equivalently, there exists a choice function which, when we apply it to the set of dogs, returns one that barks.

The extra power of Choice Raising compared with Existential Raising comes from the fact that we can give the Choice Closure operator $\exists$ nonlocal scope. This is motivated from the literature on choice functions. Indeed, the ability of indefinites to take nonlocal scope was the original motivation for their analysis in terms of choice functions.

This tree for the noun phrase of sentence (42), shown below, conveys the idea. I have omitted the definedness condition $N \neq \emptyset$ to avoid clutter. This restriction to nonempty sets is vacuous in this example given that John is a man, but it will do real work in other cases. For example, the restriction will make sure that *man and woman* fails to denote anything in all-male or all-female models.

(50)


The term at the root of the tree in (50) denotes the set of all properties P such that there is a way of choosing a man such that P holds of John and of that man, but of nothing else. Given that John is a man, any such property will either be the singleton of John, or it will be a set of two men, one of which is John. So we can represent the term at the root of the tree more simply as follows:

(51) $[\![$[∃ [λ_1[MIN [John and [some$_1$ man]]]]]$]\!] = \lambda P \exists x \in \mathbf{man}.P = \{j\} \cup \{x\}$

From now on, in my LFs I will collapse the ∃ operator with lambda abstraction. For example I will write $[\exists_1[\ldots$ instead of $[\exists[\lambda_1[\ldots$. This is harmless because I assume that the two always go together, as mentioned above. For example, I will abbreviate the LF in (51) as follows:

(52) $[\![$[$\exists_1$[MIN [John and [some$_1$ man]]]]$]\!] = \lambda P \exists x \in \mathbf{man}.P = \{j\} \cup \{x\}$

Given that John is a man, the LF in (52) denotes the set of all those sets that contain either only John, or else John and another man but nothing else. For example, if there are exactly three men, namely John, Bill, and Sam, the LF in (52) will denote the following set:

(53) $\{\{j\}, \{j, b\}, \{j, s\}\}$

If we want to combine (52) with a verb phrase such as *met*, we can do so by an application of Existential Raising, as in the analysis of *John and Mary met*, whose noun phrase is shown in (39). In the same model as above, this results in:

(54) $[\![$[[ER[$\exists_1$[MIN [John and [some$_1$ man]]]]] met]$]\!] = \exists P \in \{\{j\}, \{j, b\}, \{j, s\}\} \cap \mathbf{meet}$

In words, this is true if and only if one of the collective individuals in the set (53) is in the set denoted by *meet*. Since that predicate is collective, the singleton of John will not be contained in that set. So in the model above, this will be true if John and Bill met, and it will be true if John and Sam met, and there are no other possibilities.

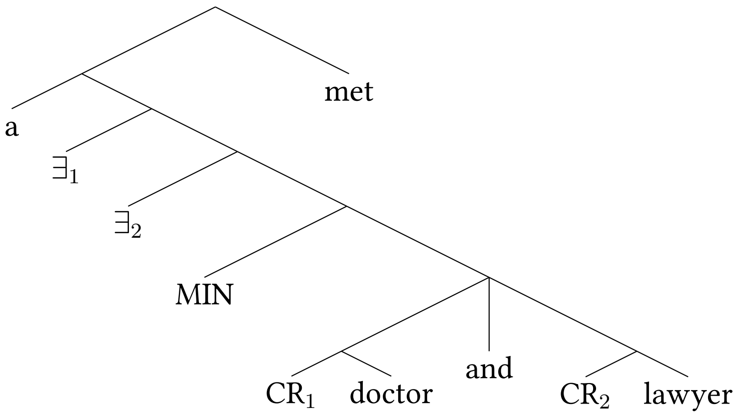
So there are two applications of Raising in Winter's analysis of *John and some man met*: one is responsible for the analysis of *some* in the subject, and the other one is responsible for combining the subject with the verb phrase. In procedural terms, by giving the existential quantifier over the choice function wide scope, Winter allows us to delay the choosing of a man until after we have minimized the set of sets containing John and that man.

4.3 Application to *doctor and lawyer*

In this subsection I show how to adapt the analysis of *John and some man met* to the case of *A doctor and lawyer met.* I assume that a silent instance of Choice Raising applies to each of the nouns and delays the choosing of a doctor and the choosing of a lawyer until after minimization has applied. For this purpose, I introduce silent and uniquely indexed operators CR_i whose meaning is the same as that of the overt indefinite *some$_i$* defined in (44). I assume that these operators are found in adjectival position, just next to the nouns they apply to, replacing and generalizing the ER operators I have used before.

To obtain the denotation of (40), we use the entry for *a* in (23) and the entry for *meet* in (22b), in a way analogous to the analysis of *A man and woman met in the park* in Section 2.3. The LF (40) is as follows:

(55)



This LF evaluates as follows (see below for an explanation; I leave out the nonemptiness conditions for clarity):

(56) a. $[\![\text{CR}_1]\!]^g([\![\text{doctor}]\!]^g) = \lambda P_{\langle et \rangle}.\ P(g(1)(\textbf{doctor}))$

b. $[\![\text{CR}_2]\!]^g([\![\text{lawyer}]\!]^g) = \lambda P_{\langle et \rangle}.\ P(g(2)(\textbf{lawyer}))$

c. $[\![\text{and}]\!]^g$((56a)) ((56b)) $= \lambda P_{\langle et \rangle}.\ P(g(1)(\textbf{doctor})) \wedge P(g(2)(\textbf{lawyer}))$

d. $[\![\text{MIN}]\!]^g$((56c)) $= \lambda P_{\langle et \rangle}.\ P = \{g(1)(\textbf{doctor})\} \cup \{g(2)(\textbf{lawyer})\}$

e. $[\![\exists_2]\!]^g$((56d)) $= \lambda P_{\langle et \rangle}.\ \exists f_2.\text{CF}(f_2) \wedge P = \{g(1)(\textbf{doctor})\} \cup \{f_2(\textbf{lawyer})\}$

f. $[\![\exists_1]\!]^g$((56e)) $= \lambda P_{\langle et \rangle}.\ \exists f_1 \exists f_2.\text{CF}(f_1) \wedge \text{CF}(f_2) \wedge P = \{f_1(\textbf{doctor})\} \cup \{f_2(\textbf{lawyer})\}$

g. $[\![\text{a}]\!]^g$((56f)) $= \lambda P'_{\langle et,t \rangle}.\ \exists f_1 \exists f_2.\text{CF}(f_1) \wedge \text{CF}(f_2) \wedge \{f_1(\textbf{doctor})\} \cup \{f_2(\textbf{lawyer})\} \in P'$

h. ((56g)) ($[\![\text{met}]\!]$) $= \exists f_1 \exists f_2.\text{CF}(f_1) \wedge \text{CF}(f_2) \wedge \{f_1(\textbf{doctor})\} \cup \{f_2(\textbf{lawyer})\} \in \textbf{meet}$

The last step, (56h), is equivalent to the following:

(57) $\exists x \exists y.\textbf{doctor}(x) \wedge \textbf{lawyer}(y) \wedge \{x\} \cup \{y\} \in \textbf{meet}$

This says that there are a doctor and a lawyer and that the set that consists of the two of them met.

In procedural terms, CR_1 introduces a choice function variable whose value picks and then Lifts a certain doctor (56a); in a similar way, CR_2 picks and then Lifts a certain lawyer (56b); the lifts of the lawyer and the doctor are intersected (56c); Minimization turns that intersection into the property of being the set that contains that doctor, that lawyer, and nobody else (56d); the two Choice Closure operators existentially bind the choice function variables (56e), (56f); the indefinite determiner prepares the resulting set for combination with the verb phrase (56g); and finally, *met* checks if the lawyer and the doctor met (56h). Depending on the choice functions, the doctor may be identical to the lawyer, or there may be two distinct individuals. So if there are doctor-lawyers in the model, then among the sets denoted by *doctor and lawyer*, there will singleton sets containing them. But there will also be two-element sets containing a doctor and a lawyer, even if they happen to share one or both of their professions. So we have avoided the problem of overlappers.

This is true just in case a doctor and a lawyer met, regardless of whether they share any professions. In other words, these truth conditions will still be met if the person identified as a doctor also happens to be a lawyer, and vice versa. (The word *meet* will require that the two individuals are distinct, since world knowledge tells us that it takes two for a meeting. I have not represented this requirement explicitly here.)

4.4 The scope of Choice Closure

In this subsection I discuss the consequences of the additional degree of freedom that we have gained by moving from Existential Raising to Choice Raising. Essentially, we have decoupled the scope of the location where the choice is made (the Choice Closure operator, $\exists_i$) from that of the location at which coordination is interpreted (the Choice Raising operator, CR_i). As can be seen in (55), I have allowed Choice Closure to take scope above Minimization. If I had left Choice Closure under Minimization, the result would have been equivalent to using Existential Raising, since the latter can be seen as a local combination of an Choice Raising operator with an Choice Closure operator.

Whenever we have an operator that can take nonlocal scope, there is a question as to how wide its scope can be. The following two attested examples, and the oddity of the suggested paraphrases, make it clear that the scope-taking abilities of Choice Closure need to be constrained.

(58) a. A set of pairings is called stable if under it there is no man and woman who would both prefer each other to their actual partners.[1]

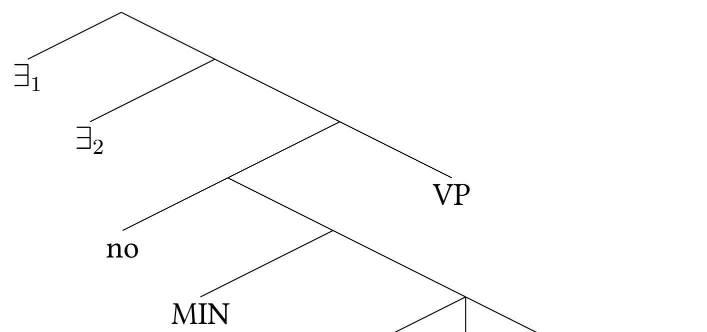
b. #There are a man and a woman such that a set of pairings is called stable if under it they would not both prefer each other to their actual partners.

(59) a. No matter how much they desire children, no man and woman have a right to bring into the world those who are to suffer from mental or physical affliction.[2]

b. #There are a man and a woman who do not have a right to bring into the world those who are to suffer from affliction.

The problem in (58b) and (59b) is that Choice has taken scope out of a non-upward-entailing context, namely the restrictor of *no*. That is, configurations like the following do not seem to be allowed:

(60)



There seems to be a contraint that prevents $\exists_i$ from taking scope above *no*. I have no explanation for this constraint, but it comes with the territory. Independent evidence for its existence can be seen in the fact that existential quantifiers over choice functions in general are unable to take scope above non-upward-entailing operators Schwarz (2001, 2004). For relevant discussion on the scope of choice function operators, see also Schlenker (2006). For example, sentence (61a) does not have a reading that could be paraphrased as (61b).

[1] www.usc.edu/programs/cerpp/docs/Two-SidedMatching.docx

[2] http://www.nyu.edu/projects/sanger/webedition/app/documents/show.php?sangerDoc=237888.xml

(61) a. No woman read some book I recommended.
b. There is a choice function f such that no woman read that book I recommended which f assigns to her.

This missing reading could also be paraphrased as "There is a way to assign books I recommended to women such that no woman read the book assigned to her", which is another way to say "No woman read every book I recommended". This reading is unavailable.

An analogous phenomenon occurs in connection with indefinites that contain bound syntactic variables, such as bound pronouns, as Schwarz discusses:

(62) No woman read some book I recommended to her.

This sentence uses a bound pronoun to make the dependency between women and books explicit, and it does not have the missing reading paraphrased above any more than sentence (61a) does.

Because of the need to impose constraints on the scope of their binders, choice functions have been argued to fail as a plausible model of the semantics of indefinites (Heim, 2011; Charlow, 2014). Here, I have suggested that we can hold on to choice functions as long as we introduce constraints on the scope of the existential quantifiers that bind them. These constraints are different from the familiar island constraints on universal quantifiers, so the question arises whether such constraints can be plausibly motivated. The fact that choice function binders must be constrained both in the case of indefinites and in the case of coordination can be seen either in a pessimistic light, given that choice functions were originally motivated by the need to give indefinites a way to escape island constraints, or in a more optimistic light, given that the need to constrain them seems independent in the two cases I have discussed here. While choice functions may or may not turn out to be the best way to model the scopal behavior of indefinites, the result I want to emphasize by way of summarizing this section is this: There is a parallel between the need to fix the choice of referent for an indefinite independently of the place at which it takes scope, and the need to fix the choice of "referent" for each noun in a *doctor and lawyer* style conjunction outside of the scope of that conjunction.

To summarize this section, I have shown how replacing Existential Raising by Choice Raising allows us to extend the intersective theory from cases without overlap, like *man and woman*, to cases with overlap, like *doctor and lawyer*. The replacement is independently needed in order to handle noun phrase conjunctions like *John and some man met* (Winter, 2001). Since Existential Raising can be seen as a special case of Choice Raising, we have not lost anything in the process. The choice functions that we have introduced need to be constrained in their scope in ways that are similar to those discussed in Schwarz (2001, 2004).

5 How many people are five men and women?

In this section, I extend the theory developed so far from the singular to the plural, in order to deal with sentences that involve coordination of plural nouns, such as the one in the title of this paper. This will require combining Choice Raising with Predicate Distributivity, two operators we have seen before.

Collectively interpreted conjunctions of plural nouns are in principle ambiguous as to the number of entities involved. In English, a noun phrase like *five men and women* can either involve reference to a group of ten people, five of which are men and five are women, or to a group of five people that includes members of both sexes (Dalrymple, 2004; King & Dalrymple, 2004). These two readings are attested in (63) and (64), respectively. I will refer to them as the ten-people reading and the five-people reading.

(63) **Ten people in total:**
Five men and women, representing the five military services, will learn who becomes the 1995 winners when the U.S. Military Sports Association announces the male and female winners here Jan. 19. In the mens category, the candidates are ... [list of five names]. Competing for the female athlete of the year are ... [list of five names][3]

(64) **Five people in total:**
Five men and women from four states have been elected to serve on the University of Iowa Foundation Board of Directors. At its October meeting, the Foundations Board of Directors elected ... [list of five names][4]

The next two subsections show how to account for each of these readings within the intersective theory of *and*, starting with the ten-people reading (Section 5.1) and going on with the five-people reading (Section 5.2). The latter reading requires us to combine Predicate Distributivity and Choice Raising to a new operator I call Distributive Choice Raising. I provide independent motivation for that operator in the rest of this section.

5.1 Determiner doubling

This subsection shows that the ten-people reading is compatible with the intersective theory of *and*. In this reading, the numeral *five* appears to be interpreted twice, what we might call determiner doubling. This can be implemented, for example, via syntactic deletion of the numeral or via some semantic equivalent of it. In a syntactic deletion account, the noun phrase in (63) would be analyzed as underlyingly involving a silent copy of *five*, like this:

(65) five men and ~~five~~ women

A semantic implementation of this idea is found in Cooper (1979). It is further discussed in various places (Partee & Rooth, 1983; Dowty, 1988; Winter, 1998). An illustration of Cooper's idea for a singular conjunction *this man and woman* follows. It is taken from Dowty (1988), who attributes the illustration to Mats Rooth. Here, **this** is a function from sets to generalized quantifiers, and D is a variable of type $\langle et, \langle et, t\rangle\rangle$ over such functions.

(66) a. $[\![\text{man}]\!] = \lambda D_{\langle et,\langle et,t\rangle\rangle}.D(\mathbf{man})$
b. $[\![\text{woman}]\!] = \lambda D.D(\mathbf{woman})$
c. $[\![\text{man and woman}]\!] = [\lambda D.D(\mathbf{man}) \ \cap \ \lambda D.D(\mathbf{woman})]$
$= \lambda D.[D(\mathbf{man}) \ \cap \ D(\mathbf{woman})]$
d. $[\![\text{this man and woman}]\!]$
$= \lambda D.[D(\mathbf{man}) \ \cap \ D(\mathbf{woman})](\mathbf{this})$
$= [\mathbf{this}(\mathbf{man}) \ \cap \ \mathbf{this}(\mathbf{woman})]$

This line of analysis involves raising the type of each noun so that it expects the determiner as an argument, then intersecting the two type-raised nouns, and finally combining them with the determiner. It is straightforward to adapt this analysis to the ten-people reading of *five*

[3] From `www.defenselink.mil/news/Jan1996/n010419969601043.html`, cited in Dalrymple (2004).
[4] From `www.uifoundation.org/news/1999/dec05.shtml`, cited in Dalrymple (2004).

men and women illustrated in (63). Since this derivation involves intersection, this reading does not represent a challenge to the intersective theory.

Rooth's derivation suggests at first sight that even singular noun-noun coordination could be handled by raising the type of the determiner. As was already pointed out in Heycock & Zamparelli (2005, p. 254), this will not work, because on this theory, *man and woman* does not denote the set of heterosexual couples, in contradiction to what I have shown in Section 2.1. Rather, as shown in (66c), the denotation of *man and woman* denotes a property of functions of type $\langle et, \langle et, t\rangle\rangle$. This property cannot be used in order to derive the meanings of sentences like (6), since it cannot be intersected with hydras, and more generally it is not clear how to combine it with collective predicates. So, while this kind of derivation is needed in order to account for the ten-people reading, it will not be able to do all the work.

5.2 Man-woman mixtures

This subsection discusses the challenges that the five-people reading illustrated in (64) presents for the intersective theory of *and*. This reading cannot be generated by a Cooper-style analysis as discussed in the previous subsection. On Cooper's line of analysis, *five men and women* would denote the set of all properties P such that five men have P and five women have P. But this is the "ten people" reading, not the "five people" reading.

Let me now show how to derive the five-people reading using the theory developed in this paper so far. To do this I will need one additional assumption: Raising sometimes composes with Predicate Distributivity.

For sets P and Q, define a *P/Q-mixture* as any union of a nonempty subset of P with a nonempty subset of Q. So a man/woman-mixture is a set which contains at least one man, at least one woman, and nothing which is neither a man nor a woman. Given this, we can represent the five-people reading of *five men and women* as follows:

(67) ⟦five men and women⟧ = $\{P_{et} :\ |P| = 5$ and P is a man/woman-mixture $\}$

I have already talked in Section 3.1 about the assumption that numerals have the same type as intersective adjectives (e.g. Verkuyl, 1981; Landman, 2004, ch. 1). So for example, *five* denotes the set of all those sets that contain exactly (or at least) five individuals. I will adopt this assumption now because it makes things easy, but I would also be able to represent numerals as predicate modifiers Winter (e.g. 2001). Here is my entry for the numeral *five*:

(68) ⟦five⟧ = $\{P_{et} :\ |P| = 5\}$

This set is intersected with the plural noun. I follow Winter (2001) in analyzing plural nouns as being derived from the singular noun via the PDIST operator defined in (27) and repeated below as (69). For example, the result of applying PDIST to *man* is shown in (70). Here, $\wp$ is the powerset operator. The result of the intersection of *five* with *men* is shown in (71).

(69) **Predicate Distributivity:** (Winter, 2001)
$[\![\text{PDIST}]\!] = \lambda P'_{et}\lambda P_{et}.P \neq \emptyset \wedge P \subseteq P'$

(70) ⟦men⟧ = ⟦PDIST(man)⟧ = $\{P_{et} : P \neq \emptyset \wedge P \subseteq \mathbf{man}\} = \wp(\mathbf{man})\backslash\emptyset$

(71) ⟦five men⟧ = $\{P_{et} :\ |P| = 5\ \wedge\ P \neq \emptyset \wedge P \subseteq \mathbf{man}\}$

While PDIST is incompatible with empty sets, it is compatible with singletons. This implements the view that the plural form of a count noun denotes a superset of its singular form.

For example, the property denoted by *students* holds of sets of one or more students (Krifka, 1986). On this view, the *more than one* component of the plural can be treated, for example, as a grammaticalized scalar implicature (Spector, 2007; Zweig, 2009). The "two or more" component is not present in certain contexts. Thus, one can comply with an instruction to *take five fruits and vegetables* even by taking just one fruit and four vegetables (Y. Winter, p.c.).

The question now is how to derive a predicate *men and women* that intersects with *five* in the desired way, analogously to the way *men* intersects with *five*. That is, how do we derive the following predicate:

(72) $[\![\text{men and women}]\!] = \{P_{et} : \ P \text{ is a man/woman-mixture } \}$

Neither of the Raising operators developed above will produce the set of all man/woman mixtures that we need in order to derive (72). For example, if we pick a set of men and a set of women, and minimize the intersection of their Montague lifts, this gives us the set of all pairs that consist of a set of men and a set of women. But pairs are too small to be in the denotation of *five* since they are of cardinality two. An example of this problematic derivation is shown in (73a). For clarity, this example uses Existential Raising rather than Choice Raising, but the choice between the two options does not matter here. Both variants of Raising would fail because they would both lead to a set of cardinality two.

(73) a. $[\![\text{MIN(ER(PDIST(man)) and ER(PDIST(woman)))}]\!]$
$= \{\{M, W\} \ : \ M \neq \emptyset \wedge M \subseteq \textbf{man} \wedge W \neq \emptyset \wedge W \subseteq \textbf{woman}\}$

b. $[\![\text{five}]\!] \cap \text{(73a)} = \emptyset$

At this point we might consider giving up the assumption that the semantics of numerals is intersective. This is doable, and it is in fact supported by languages like Hungarian and Turkish where numerals combine with morphologically singular nouns and therefore cannot be intersective. But in English, there is no immediate motivation for doing so, and so I will make another proposal, one that has independent support. In Section 5.3, I describe the proposal and how to apply it to noun-noun coordination. In Section 5.4, I provide independent motivation for it, in part novel and in part from Winter (2001).

5.3 Distributive Choice Raising derives mixtures

This section explains my proposal to combine Choice Raising with Predicate Distributivity. In order to distinguish between Choice Raising as I have used it above, and its combination with Predicate Distributivity as I will introduce it here, I will refer to the former as Nondistributive Choice Raising and to the latter as Distributive Choice Raising. I will assume that Nondistributive Choice Raising applies to singular nouns and Distributive Choice Raising to plural nouns. For example, I will assume that Nondistributive Choice Raising is at work in *man and woman*, and that Distributive Choice Raising is at work in *men and women*.

I will continue to write (Nondistributive) Choice Raising as CR, and I will write Distributive Choice Raising as DCR. The notation in Winter (2001) for these two operators is $\langle f \rangle$ and $\langle f^d \rangle$. I repeat the definition of Choice Raising from (45) for comparison in (74), and I give the definition of DCR in (75). There is a close connection between Distributive Choice Raising and Predicate Distributivity. The alternative definition in (76) makes this connection clear. This definition is equivalent to the one in (75). An explanation immediately follows.

(74) **Nondistributive Choice Raising** (same as (45)): (Winter, 2001)
$[\![\text{CR}_i]\!]^g = \lambda N_{\langle et \rangle} : N \neq \emptyset.\ \lambda P_{\langle et \rangle}.\ g(i)(N) \in P$

where $g(i)$ is a choice function of type $\langle et, e \rangle$

(75) **Distributive Choice Raising:** (Winter, 2001)
$[\![\text{DCR}_i]\!]^g = \lambda N_{\langle et,t \rangle} : N \neq \emptyset.\ \lambda P_{\langle et \rangle}.g(i)(N) \subseteq P$
where $g(i)$ is a choice function of type $\langle \langle et, t \rangle, et \rangle$

(76) **Alternative definition of Distributive Choice Raising:**
$[\![\text{DCR}_i]\!]^g = \lambda N_{\langle et,t \rangle} : N \neq \emptyset\ .\ \lambda P_{\langle et \rangle}.\ g(i)(N) \in \text{PDIST}(P)$
where $g(i)$ is a choice function of type $\langle \langle et, t \rangle, et \rangle$

Nondistributive Choice Raising is defined in (74) as the Montague Lift of the variable that is selected by its choice function. It applies a choice function to a set of individuals, chooses one of them, and then Montague Lifts that individual to the set of all properties P such that the chosen individual has P. Distributive Choice Raising as defined in (75) applies a choice function to a set of pluralities, chooses one of these pluralities, and then returns the set of all properties P such that each of the members of the chosen plurality has P. In other words, P is required to distribute over the members of the plurality. That is why there is a close connection between Distributive Choice Raising and Predicative Distributivity, as shown in (76).

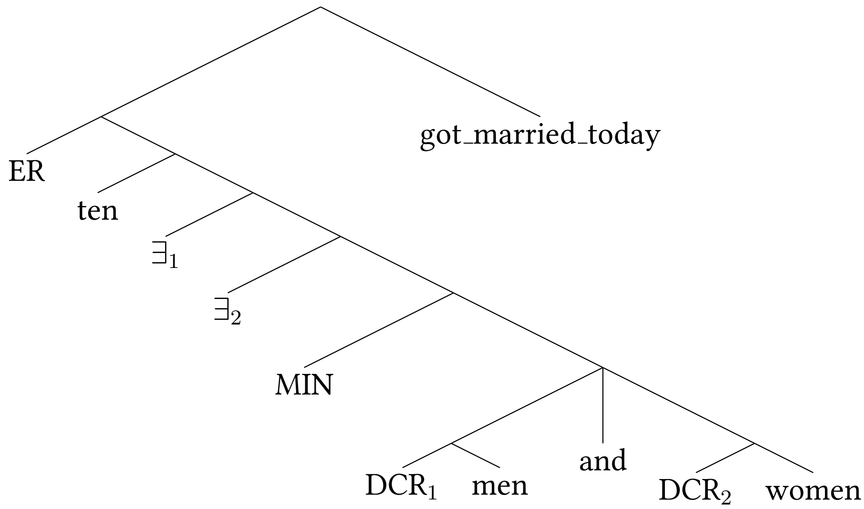
The following derivation shows how Distributive Choice Raising can be used in order to derive reading (72) for *men and women.* I write f_1 and f_2 for the choice functions introduced by the two instances of Distributive Choice Raising. I write **men** and **women** for the result of applying PDIST to the denotations of *man* and *woman*, that is, $\wp(\textbf{man})\backslash\emptyset$ and $\wp(\textbf{woman})\backslash\emptyset$. An explanation immediately follows.

(77)
a. $[\![\text{DCR}_1(\text{men})]\!] = \lambda P.\ f_1(\textbf{men}) \subseteq P$
b. $[\![\text{DCR}_2(\text{women})]\!] = \lambda P.\ f_2(\textbf{women}) \subseteq P$
c. $[\![\text{DCR}_1(\text{men}) \text{ and } \text{DCR}_2(\text{women})]\!] = \lambda P.\ f_1(\textbf{men}) \subseteq P\ \wedge\ f_2(\textbf{women}) \subseteq P$
d. $[\![\text{MIN}(\text{DCR}_1(\text{men}) \text{ and } \text{DCR}_2(\text{women}))]\!] = \lambda P.\ P = f_1(\textbf{men})\ \cup\ f_2(\textbf{women})$
e. $[\![\exists_1(\exists_2(\text{MIN}(\text{DCR}_1(\text{men}) \text{ and } \text{DCR}_2(\text{women}))))]\!]$
$= \{P\ :\ P \text{ is a man-woman mixture }\}$

In procedural terms, this is what happens. We start with the set denoted by the plural noun *men.* This is the set of all nonempty sets of men. We choose one of these sets of men and place a hold on our choice. We create the set of all those properties that hold of each of these men, that is, we create all supersets of the set of men that we chose (77a). We do the same thing for a similarly chosen set of women (77b). We combine the two sets of properties via Intersection (77c) and then apply Minimization to the result (77d). Given our fixed choice of men and our fixed choice of women, the only set that remains after Minimization is the set that contains exactly the men and the women we picked. We now release the hold on our choice of men and the hold on our choice of women (77e). This gives us the set of all properties P such that there is a way of picking some men and some women that gives us all and only the people of which P holds. In other words, we get the set of all man-woman mixtures.

Now we can derive the right truth conditions for the sentence in the title of this paper, *Ten men and women got married today.* The set of man-woman mixtures is ready to be intersected with the numeral *ten.* The result is the set of all man-woman mixtures of cardinality ten. We now use Existential Raising in order to combine *ten men and women* with *got married today.* The LF can then be given as follows.

(78)



The LF in (78) is true if and only if among the sets in the denotation of *got married*, there is a man-woman mixture of cardinality ten. To make sure that this is the case if and only if ten men and women got married, we assume that the collective predicate *got married* denotes the closure under union of the set of all married couples (where each couple is represented as a two-element set). (Alternatively, we could assume that *got married* denotes the property of being a set of two people that got married, and that it combines with the noun phrase via a process called Determiner Fitting (Winter, 2001). I come back to this point in Section 6.)

5.4 Evidence for Distributive Choice Raising

In this subsection, I provide evidence that Distributive Choice Raising is useful in empirical domains other than coordination of nouns.

The first piece of evidence comes from coordinations of verb phrases. This piece of evidence is conditional on the intersective theory of coordination being correct, so it is theory-internal. Simply put, the evidence is this. Coordinated verb phrases have joint and split readings, just like coordinated nouns. We can use Distributive Choice Raising to generate the split reading. I go over this in first piece of evidence in detail, because unlike the other pieces I discuss below, the analysis I propose here is novel.

Joint and split readings of conjoined verb phrases are discussed in Krifka (1990b) and in Winter (2001) on the basis of examples like the following:

(79) a. The ducks were swimming and quacking. *joint*
b. The ducks were swimming and flying. *split*

Sentence (79a) has a prominent joint reading, which entails that each duck was both swimming and quacking at the same time. Sentence (79b) has a prominent split reading, which only entails that each duck was either swimming or flying. Given that it is impossible for a duck to swim and fly at the same time, the joint reading of (79b) is ruled out by plausibility considerations. As a rule, sentences like (79a) in which the joint interpretation is plausible tend to lack a split reading. Winter (2001) proposes to model this behavior via an adaptation of the Strongest Meaning Hypothesis (Dalrymple et al., 1998). The idea is that in the sentences at hand, the joint reading is stronger than (i.e., is entailed by) the split reading, and therefore the joint reading surfaces whenever it does not contradict world knowledge. But Winter's account is problematic. Recent experimental work suggests that it is typicality and not strength that determines which reading surfaces in a given context (Poortman, 2014). For example, a sentence like the following tends to be interpreted with a split reading even though the joint reading is in principle possible, presumably because the joint reading would only be true in atypical situations. It is therefore plausible that the grammar generates both readings and that a subsequent pragmatic component, which I will not spell out here, selects the most typical plausible one among them. (For more criticism of Winter's account, see Heycock & Zamparelli (2005, Sect. 6.4).

(80) The boys are sitting and cooking. (Poortman, 2014)

I assume that the conjuncts in these examples are of type $\langle et, t\rangle$, and that they are derived from the type-et predicates like *sit* and *cook* via Predicate Distributivity (PDIST). This models the fact that these conjuncts denote distributive predicates: if a set of boys is PDIST-sitting then each of the members of this set is sitting, and so on. From these distributive readings, we can generate the (atypical) joint reading of a sentence like (80) directly via Intersection. As for the split reading, we can generate it by the following procedure. First apply Distributive Choice Raising to each of the conjuncts, then combine them via Intersection, and finally, retrieve the property of being a sit/cook mixture via Minimization. I assume that the plural definite article *the* takes a noun and returns the supremum of the set denoted by that noun (Montague, 1979). This is not essential. Other assumptions about the definite article would also work.

(81) $[\![\text{the}_{pl}]\!] = \mathbf{the} \stackrel{\text{def}}{=} \lambda N_{\langle et,t\rangle}.\iota x.N(x) \wedge \forall y[N(y) \rightarrow y \subseteq x]$

In the following translation, I omit double squared brackets (interpretation function brackets).

(82) **Translation of sentence (80)**:

a. $\exists_1 \exists_2\ \mathbf{the}(\mathbf{boys}) \in (\text{MIN}(\text{DCR}_1(\text{PDIST}(\mathbf{sit}))\text{ and }\text{DCR}_2(\text{PDIST}(\mathbf{cook}))))$

b. $\Leftrightarrow \exists_1 \exists_2\ \mathbf{the}(\mathbf{boys})$
$\in (\text{MIN}(\lambda P.g(1)(\wp(\mathbf{sit})\backslash\emptyset) \subseteq P)\ \cap\ (\lambda P.g(2)(\wp(\mathbf{cook})\backslash\emptyset) \subseteq P))$

c. $\Leftrightarrow\ \exists f_1 \exists f_2.\text{CF}(f_1) \wedge \text{CF}(f_2) \wedge \mathbf{the}(\mathbf{boys})\ \in\ \text{MIN}((\lambda P.f_1(\wp(\mathbf{sit})\backslash\emptyset)\ \subseteq\ P) \cap (\lambda P.f_2(\wp(\mathbf{cook})\backslash\emptyset) \subseteq P))$

d. $\Leftrightarrow \exists f_1 \exists f_2.\text{CF}(f_1) \wedge \text{CF}(f_2)$
$\wedge \mathbf{the}(\mathbf{boys}) \in \text{MIN}(\lambda P.f_1(\wp(\mathbf{sit})\backslash\emptyset) \subseteq P \wedge f_2(\wp(\mathbf{cook})\backslash\emptyset) \subseteq P)$

e. $\Leftrightarrow \exists f_1 \exists f_2.\text{CF}(f_1) \wedge \text{CF}(f_2)$
$\wedge \mathbf{the}(\mathbf{boys}) \in \lambda P.P = f_1(\wp(\mathbf{sit})\backslash\emptyset) \cup f_2(\wp(\mathbf{cook})\backslash\emptyset)$

f. $\Leftrightarrow \exists f_1 \exists f_2.\text{CF}(f_1) \wedge \text{CF}(f_2) \wedge \mathbf{the}(\mathbf{boys}) = f_1(\wp(\mathbf{sit})\backslash\emptyset) \cup f_2(\wp(\mathbf{cook})\backslash\emptyset)$

g. $\Leftrightarrow \exists P_1 \exists P_2.\ P_1 \in \wp(\mathbf{sit})\backslash\emptyset \wedge P_2 \in \wp(\mathbf{cook})\backslash\emptyset \wedge \mathbf{the}(\mathbf{boys}) = P_1 \cup P_2$

h. $\Leftrightarrow \exists P_1 \exists P_2.\ P_1 \neq \emptyset \wedge P_1 \subseteq \mathbf{sit} \wedge P_2 \neq \emptyset \wedge P_2 \subseteq \mathbf{cook} \wedge \mathbf{the}(\mathbf{boys}) = P_1 \cup P_2$

The last line of (82) is true if and only if the set consisting of all the boys is the union of a nonempty set of sitters and a nonempty set of cookers – or in other words, if and only if it is a sit/cook mixture. This is what we want.

Now let me explain why this derivation provides independent motivation that Distributive is needed in addition to Nondistributive Choice Raising. In this derivation, it was important that the verb phrases were lifted into generalized quantifiers via Distributive rather than Nondistributive Choice Raising, in order to make sure that the verb phrase *are sitting and cooking* denotes a property of sit/cook mixtures. In the derivation above, this is the case, as seen in (82d): The verb phrase denotes a property that holds of sets of which the chosen set of sitters and the chosen set of cookers are subsets. Minimization narrows this down to the property that only holds of the union of these two chosen sets. If Nondistributive Choice Raising was used instead, then we would expect that *sitting and cooking* should hold of any minimal set that contains the two chosen sets as elements, rather than as subsets. Such a set is not a sit/cook mixture.

Another type of example that motivates Distributive Choice Raising concerns conjunctions of plural noun phrases (Winter, 2001, p. 149f.).

(83) a. Two Americans and three Russians made an excellent basketball team.
b. These women are the authors and the teachers.

As Winter notes, the prominent reading of sentence (83a) is that there was an excellent basketball team which consists of two Americans and three Russians. In order to account for this reading, the subject needs to provide a set consisting of five people of the required nationalities so that the predicate denoted by *make an excellent basketball team* can apply to that set. (This verb phrase denotes a collective predicate, so there is no Predicate Distributivity operator involved in its derivation.) Without Distributive Choice Raising, this set is impossible to access. The two coordinated noun phrases are represented as predicates of pluralities. These cannot be intersected directly since their intersection is empty due to the different cardinalities (two vs. three). Applying Existential Raising to each of the conjuncts and then combining them via Intersection does not help either. As Winter shows, this would lead to a distributive interpretation that entails that there are two basketball teams of non-standard sizes. Finally, it will not do to apply Nondistributive Choice Raising to each of the conjuncts, since this would give us a set of two Americans and a set of three Russians. These sets cannot be combined in the right way: they would need to be combined via union, but the meaning of *and* is Intersection.

Winter's analysis of sentence (83a) is shown in (84) below. An explanation immediately follows.

(84) Adapted from Winter (2001, p. 156):
a. $\exists_1 \exists_2$ [ER(MIN(DCR$_1$(**two**(**americans**)) and DCR$_2$(**three**(**russians**))))
(**basketball_team**$_{\langle et,t\rangle}$)]
b. $\Leftrightarrow \exists A \subseteq$ **american** $\exists B \subseteq$ **russian** $[|A| = 2 \wedge |B| = 3 \wedge$
(ER(MIN(($\lambda P_1 . A \subseteq P_1$) and ($\lambda P_2 . B \subseteq P_2$))))(**basketball_team**)]
c. $\Leftrightarrow \exists A \subseteq$ **russian** $\exists B \subseteq$ **american** $[|A| = 2 \wedge |B| = 3 \wedge$
basketball_team$(A \cup B)]$

In (84a), one instance of Distributive Choice Raising, DCR$_1$, is used to pick two Americans and return the set of all those properties that hold of each of them. Another instance of Distributive Choice Raising, DCR$_2$, is used to pick three Russians and return the set of all those properties that hold of each of them. The result is sent through Intersection and Minimization, and is combined with the verb phrase, a predicate of collective entities. Finally, the choice function variables introduced by the two Raising operators are existentially bound via two instances of Choice Closure. The result simplifies as shown in (84b) and (84c). The resulting formula is true iff there exist a two-element set of Russians and a three-element set of Americans whose union forms an excellent basketball team. As for sentence (83b), the Choice Raising mechanism operates in a similar way (for details, see Winter (2001)).

For completeness, let me mention the examples that originally motivated Distributive Choice Raising in Winter (2001). I do so with the caveat that these examples can also be analyzed using a combination of Nondistributive Choice Raising and Predicate Distributivity, as a reviewer notes. But they may still be helpful in order to understand where Distributive Choice Raising comes from and what it can be used for.

Based on earlier work by Eddy Ruys, Winter observes that the existential component and the distributive component of indefinite numerals like *three workers* can have two distinct scopes. Sentence (85) has a reading that does not involve three specific workers and a reading that does. These readings are paraphrased in (85a) and in (85b) respectively (Ruys, 1992; Winter, 2001). For an in-depth discussion of the different scope-taking properties of the existential and the distributive scope component of indefinite numerals, see also (Szabolcsi, 2010, ch. 7).

(85) If three workers in our staff have a baby soon, we will have to face some hard organizational problems.

a. If any three workers each have a baby, there will be problems. if $> 3 > D > 1$

b. There are three workers such that if each of them has a baby, there will be problems. $3 >$ if $> D > 1$

In the latter reading, the existential component of *three workers* takes scope outside of the antecedent of *if*, but the distributive component takes scope inside of it. Since antecedents of *if*-clauses are islands for quantifiers, this shows that the existential component of *three workers* is not island-bound, a fact that is familiar from the literature on choice functions (e.g. Reinhart, 1997). Unlike the existential component, however, the distributive component cannot take scope outside of the *if*-island. If it could, sentence (85) should have a reading that can be paraphrased as follows, contrary to fact:

(86) There are three workers such that for each x of them, if x has a baby, there will be problems. *$3 > D >$ if > 1

To model this behavior, Winter puts a combination of Choice Raising and Choice Closure to work, and he assumes that islands trap Choice Raising but let Choice Closure escape. Here is how Winter analyzes reading (85b) of sentence (85) (with some adjustments to match the notation I have introduced). An explanation immediately follows.

(87) $[\exists_1[\mathrm{DCR}_1(\mathbf{three}(\mathbf{workers}))(\lambda x.\exists y(\mathbf{baby}(y) \wedge \mathbf{have}(y)(x))) \rightarrow \mathbf{problems}]]$

The predicate **workers** is a shorthand for the application of Predicate Distributivity to the predicate **worker**, since this is how Winter (as I do) represents the semantic contribution of the plural morpheme. The predicate **problems** is a shorthand for the proposition denoted by the consequent. I will use similar shorthands below. The component $\mathrm{DCR}_1(\mathbf{three}(\mathbf{workers}))$ involves Distributive rather than Nondistributive Choice Raising. This is needed in order to distribute the property of having a baby down to each of the three workers. This component denotes the set of all those properties that hold of each of the three workers picked by the choice function associated with the index 1. The component $\exists_1$ existentially quantifies over this choice function. The Distributive Choice Raising component takes scope below the implication arrow, while the $\exists$ component takes scope above it. This is exactly the configuration we need for reading (85b).

An alternative, which Winter does not adopt, would be to use the PDIST operator in order to shift the property $\lambda x.\exists y(\mathbf{baby}(y) \wedge \mathbf{have}(y)(x))$ into a predicate that holds of any set just in case each of its members had a baby. In that case, the switch from Nondistributive to Distributive Choice Raising would not have been necessary. For example, as one reviewer points out, reading (85b) of sentence (85) can be modeled as involving verb phrase distributivity instead of noun phrase distributivity, as shown in (88). This requires a generalization of the Choice Raising operator in (45) so that $g(i)$ can be a choice function of arbitrary type.

(88) $[\exists_1[\text{CR}_1(\mathbf{three}(\mathbf{workers}))(\text{PDIST}(\mathbf{have\_a\_baby})) \rightarrow \mathbf{problems}]]$

To summarize this subsection, I have presented several pieces of evidence for Distributive Choice Raising. The first piece of evidence concerned split readings of verb phrase coordination, for which I have proposed a novel analysis based on Distributive Choice Raising. I have shown that Nondistributive Choice Raising would not allow us to derive mixtures in the way that Distributive Choice Raising does. The second piece of evidence concerned conjunctions of plural noun phrases. Here, I have summarized the argument for Distributive Choice Raising made in Winter (2001). It is of a similar kind to the one based on verb phrase coordination. Finally, I have shown that Distributive Choice Raising predicts the ability of plural numerals to take existential and distributive scope in different places.

Let me now summarize the entire section. I have extended the theory developed in the first part of the paper from the singular to the plural. The main innovation as I did so consisted in combining Choice Raising with Predicate Distributivity. This allowed us to maintain the intersective theory of *and*. We were able to counteract the pressure of the Minimization operation by taking subsets of the two plural nouns with arbitrary cardinalities. The case of plural nouns is particularly important because one of the readings in question, the one I have called the five-people reading, does not lend itself to an analysis in terms of determiner doubling or determiner deletion, of the kind that had been proposed several times since Cooper (1979).

6 The relationship between *and* and *or*

The intersective theory of coordination suggests that there is a close relationship between *and* and *or* in natural language, analogous to the close relationship between intersection and union in many logics. Any set of assumptions surrounding an intersection-based entry for *and* need to be tested with respect to whether they interact correctly with a union-based entry for *or*. Accordingly, this section deals with relationship between *and* and *or* in noun coordinations. Section 6.1 introduces and solves a puzzle concerning that relationship due to Bergmann (1982). Section 6.2 provides an explanation of the typological observation that I described in the introduction, namely that across languages, disjunction is never associated with collective uses, while conjunction often is.

6.1 Bergmann's puzzle

Bergmann challenges the intersective theory based on examples that involve noun-noun coordination, by raising the following question: Why are the sentences in (89a) equivalent while those in (89b) are not?

(89) a. Every cat and dog is licensed. $\Leftrightarrow$ Every cat or dog is licensed.
b. A cat and dog came running in. $\not\Leftrightarrow$ A cat or dog came running in.

Most scholars who adopt the intersective theory of coordination assume that it applies in equal ways to *and* and *or*. I will assume the same here. That is, I adopt the following entry for *or*, analogous to the intersective entry for *and* shown in (17). For details, for example Partee & Rooth (1983).

(90) $[\![\text{or}_{bool}]\!] = \begin{cases} \vee_{\langle t,tt\rangle} & \text{if } \tau = t \\ \lambda X_\tau \lambda Y_\tau \lambda Z_{\sigma_1}.X(Z)[\![or]\!]_{\langle\sigma_2,\sigma_2\sigma_2\rangle}Y(Z) & \text{if } \tau = \sigma_1\sigma_2 \end{cases}$

For the purpose of this paper, we only need the following simplified entry, which is a special case of (90):

(91) $[\![\text{or}]\!] = \lambda P_{\tau t}\lambda Q_{\tau t}.P \cup Q$

To solve Bergmann's puzzle, we first need to adopt a theory of how distributive quantifiers like *every* interact with collective predicates in restrictor position, like *cat and dog*. Different kinds of collective predicates are compatible with different kinds of distributive quantifiers. For example, the distributive quantifier *all* is incompatible with certain collective predicates such as *be numerous*, but it is compatible with other ones such as *met, gathered, watched a movie together, read the same book, read different books* and so on (e.g. Kroch, 1974; Dowty, 1987; Moltmann, 1997; Champollion, to appear). The distributive quantifier *every* is incompatible with *met, gathered* or *be numerous*, but it is compatible with predicates derived from *same* and from singular *different*, such as *read the same book* and *read a different book* (Carlson, 1987; Barker, 2007). These predicates can be viewed as collective predicates.

I have argued in Section 2.1 that collective coordinations such as *man and woman* denote collective predicates. Sentences like the one in (89a) show that they are among the kinds of collective predicates that can combine with *every*. Unlike *read the same book* and similar cases, in this case the predicate is in restrictor position and not in nuclear scope position. But the fact remains that in order to deal with sentences like the one in (89a), we need a theory that explains how distributive determiners can combine with collective predicates. One such theory is provided in Winter (2001, 2002). I will adopt it here.

As mentioned, I model collective predicates as set predicates, so their type is $\langle et, t\rangle$. The next step is for the nominal, be it *man and woman* or *cat and dog*, to combine with the determiner. Ordinary determiners expect their restrictor and their nuclear scope to be of type $\langle et\rangle$. In order for determiners to combine with $\langle et, t\rangle$-type predicates instead, I assume following Winter that they are adjusted via an operator he calls determiner fitting. This operator is defined as follows:

(92) **Determiner fitting**
$[\![\text{DFIT}]\!] = \lambda D_{\langle et,\langle et,t\rangle\rangle}\lambda A_{\langle et,t\rangle}\lambda B_{\langle et,t\rangle}.D(\bigcup A)(\bigcup(A \cap B))$

Winter motivates this operator by sentences like (93), in which the collective predicate *met* is an argument of a quantificational determiner.

(93) No students met.

Winter assumes that the plural morpheme on *students* triggers the insertion of a Predicative Distributivy (PDIST) operator, as defined in (27). In Winter's system, this operator also prepares ordinary $\langle et\rangle$-type predicates so they may combine with determiners that have been adjusted for $\langle et, t\rangle$-type predicates via determiner fitting. This is relevant, for example, when a fitted determiner combines with two predicates, of which one is of type $\langle et, t\rangle$ and the other one is of type $\langle et\rangle$, as in *No students smiled.*

Using Determiner Fitting and Predicate Distributivity, Winter analyzes sentence (93) in terms of the meanings of singular *no* and *student.* Its meaning is predicted to be "No student is a member of a set of students that met".

(94) $[\![\text{DFIT(no)(PDIST(student))(met)}]\!]$
$= [\![\text{no}]\!](\bigcup \text{PDIST}([\![\text{student}]\!]))(\bigcup (\text{PDIST}([\![\text{student}]\!]) \cap [\![\text{met}]\!]))$
$= [\![\text{no}]\!]([\![\text{student}]\!])(\bigcup \{P \in [\![\text{met}]\!] : P \subseteq [\![\text{student}]\!]\})$
$= \neg\exists x.\ [\mathbf{student}(x) \wedge \exists P.\ x \in P \wedge P \in \mathbf{meet} \wedge \forall y. y \in P \rightarrow \mathbf{student}(y)]$

Now let me present a solution to Bergmann's puzzle. For the sentences in (89a), the present system generates two equivalent LFs, shown in (95) and (96) along with their translations. (These sentences also have other possible LFs. The first sentence in (89a) has an LF that translates to the nonsensical interpretation *Everything that is both a cat and a dog is licensed*, which I assume is ruled out via considerations of plausibility.) An additional LF of the second sentence in (89a) will be discussed shortly.) For convenience, I ignore the existential import of *every* and treat it as simply denoting the subset relation. I treat the verb phrases *came running in* and *be licensed* as unanalyzed predicates. They are distributive predicates, or atom predicates in the sense of Winter (2001), which means that they do not by themselves trigger determiner fitting. The application of Determiner Fitting in (95a) is triggered by the type of the collective predicate *cat and dog*, which is treated in the same way as *man and woman* above. In a slight departure from Winter (1998), who assumes that applying Determiner Fitting changes the pronunciation of *every* to "all", I assume that the pronunciation of *every* is not affected when the conjoined noun phrases are singular.

(95) a. DFIT(every)(MIN(ER(cat) and$_{bool}$ ER(dog)))(PDIST(be_licensed))
b. $\bigcup\{\{x,y\}|\mathbf{cat}(x) \wedge \mathbf{dog}(y)\} \subseteq \bigcup\{\{x,y\}|\mathbf{cat}(x) \wedge \mathbf{dog}(y) \wedge \{x,y\} \subseteq \mathbf{be\_licensed}\}$

(96) a. every(cat or$_{bool}$ dog)(be_licensed)
b. $\mathbf{cat} \cup \mathbf{dog} \ \subseteq \ \mathbf{be\_licensed}$

The translations in (95b) and (96b) are equivalent, as the reader may verify. As for the sentences in (89b), there is no way to generate equivalent LFs for them. For example, the LFs in (97a) and (98a) correspond to the most prominent (if not the only) readings of the two sentences in (89b), and they evaluate to the nonequivalent formulae in (97b) and (98b).

(97) a. DFIT(a)(MIN(ER(cat) and$_{bool}$ ER(dog)))(PDIST(come_running_in))
b. $\exists x \exists y. \mathbf{cat}(x) \wedge \mathbf{dog}(y) \wedge \{x,y\} \subseteq \mathbf{come\_running\_in}$

(98) a. a(cat or$_{bool}$ dog)(come_running_in)
b. $\exists x.(\mathbf{cat}(x) \vee \mathbf{dog}(x)) \wedge \mathbf{come\_running\_in}(x)$

In (97), I have applied Determiner Fitting to the existential determiner *a*. Strictly speaking, this is not needed. Indeed, in the rest of the paper I have omitted this step whenever possible. But in the interest of uniformity, we might try to apply Determiner Fitting across the board, whenever we combine a determiner with a collective predicate. The reader might wonder if applying Determiner Fitting to the determiner *a* ever changes the truth conditions of the sentence that contains it. The answer is no, as long as we assume the VP does not apply to the empty set. (This is a safe assumption, since a VP that combines with a Fitted determiner is either a set predicate, in which case its elements represent collective individuals and are therefore nonempty sets, or it is derived via Predicate Distributivity, in which case the empty set is excluded by definition.) To see this, assume that NP and VP are two sets of sets. Now $\mathbf{a}(\text{NP}, \text{VP})$ is true by definition iff $\text{NP} \cap \text{VP}$ is nonempty, and $\text{DFIT}(\mathbf{a})(\text{NP}, \text{VP})$ is true iff $(\bigcup \text{NP}) \cap (\bigcup(\text{NP} \cap \text{VP}))$ is nonempty. The latter term is equivalent to $\bigcup(\text{NP} \cap \text{VP})$, and this set is empty just in case $\text{NP} \cap \text{VP}$ is either empty or it only contains the empty set, contrary to assumption. So, $\mathbf{a}(\text{NP}, \text{VP})$ is true iff $\text{DFIT}(\mathbf{a})(\text{NP}, \text{VP})$ is true.

6.2 Why *or* is never collective

Unlike *and*, which is descriptively ambiguous between intersective and collective uses, *or* has no such seeming ambiguity in any known language (Payne, 1985). As I have mentioned in the introduction, this provides strong motivation against accounts that attribute collective uses of *and* to this word being ambiguous between an intersective and a collective entry (Winter, 2001). The reason is that such accounts provide no explanation of the fact that *or* is not ambiguous in the same way as *and*. In this subsection, I show that Winter's general answer to this question extends to th present system.

I have argued at length that a surface string of the shape *N1 and N2* can correspond to the two LFs "N1 and N2" and "MIN(ER(N1) and ER(N2))". These two structures have completely different readings: the joint and the split reading, respectively. This explains why *and* sometimes looks like intersection and sometimes like collective formation. As for noun-noun disjunction, however, the situation is different. Consider a string of the shape *N1 or N2*. The null assumption is that the same structures are generated as before: "N1 or N2" and "MIN(ER(N1) or ER(N2))". You might expect that this incorrectly predicts that *or* is ambiguous in an analogous way to *and*. But as it turns out, these two structures evaluate to almost the same thing, and the remaining difference between them disappears because of Determiner Fitting. While "N1 or N2" underlies the derivation in (96) above, "MIN(ER(N1) or ER(N2))" underlies the following derivation. As before, I assume that *or* denotes union in the sense of the entry in (91).

(99) a. DFIT(every)(MIN(ER(cat)) or MIN(ER(dog)))(PDIST(be_licensed))
b. = DFIT(every)(MIN($\{P|P \cup$ **cat** $\neq \emptyset \vee P \cap$ **dog** $\neq \emptyset\}$)($\{P|P \neq \emptyset \wedge P \subseteq$ **be_licensed**$\}$)
c. = $\bigcup\{\{x\}|x \in (\textbf{cat} \cup \textbf{dog})\} \subseteq \bigcup(\{\{x\}|x \in (\textbf{cat} \cup \textbf{dog})\} \cap \{P|P \neq \emptyset \wedge P \subseteq \textbf{be\_licensed}\}$
d. = $(\textbf{cat} \cup \textbf{dog}) \subseteq ((\textbf{cat} \cup \textbf{dog}) \cap \textbf{be\_licensed})$
e. = $(\textbf{cat} \cup \textbf{dog}) \subseteq \textbf{be\_licensed}$

The last line of (99) is equivalent to (96). In other words, when we take the two LFs that lead to the "joint" and "split" readings of *and*, and replace *and* by *or* in them, the two LFs turn out to have identical truth conditions.

While the present system predicts that conjoining nominals can sometimes lead to an interpretation that closely resembles the interpretation of a phrase with disjunction, the converse is not predicted. This seems right in many cases. For example, *A linguist or philosopher came running in* can neither be interpreted as talking about a linguist-philosopher, not as talking about a linguist and a philosopher. To be sure, there are well-known contexts involving free choice in which conjunction does seem to be interpreted as disjunction. For example, sentence (100a) can be paraphrased as (100b) (for discussion see Zimmermann, 2000):

(100) a. Mr. X might be in Victoria or he might be in Brixton.
b. Mr. X might be in Victoria and he might be in Brixton.

This has been taken to suggest that there is a covert operator that maps each connective onto its dual (Barker, 2010). The present approach presents a more asymmetric picture. This is motivated by the fact discussed above that only *and* but not *or* is able to give rise to collectivity effects crosslinguistically. It is not immediately clear in what way the present approach can be extended to the behavior of sentential connectives under free choice.

To summarize this section, I have shown that the present system correctly predicts the relationship between *and* and *or*. In English, the two of them have their basic meanings that can be described in terms of intersection and union. Applying Raising and Minimization gives *and* a union-like behavior, but turns out not to affect the behavior of *or*. This also provides an explanation of the observation that across languages, it is always *and* and not *or* that is associated with collective-formation behavior.

7 Comparison to previous work

Like any system that adopts a uniform meaning for *and*, this one avoids redundancy of lexical entries. This improves the ambiguity theory, that is, on the view that some instances of *and* are intersective and others are collective (Link, 1984; Hoeksema, 1988). Since the meaning I adopt is intersective, it generalizes without problems to sentential coordination, verb-phrase coordination, and noun phrase coordination (Gazdar, 1980). This improves on the implementation of the collective theory in Heycock & Zamparelli (2005), one of the few journal-length treatments of the semantics of noun-noun coordination. Noun-noun coordination is discussed in Winter (1995) and Winter (1998) though not in Winter (2001). The present system is vastly different from the treatment of noun-noun coordination in Winter (1998). In this section, I discuss Heycock & Zamparelli (2005) and Winter (1998) in more detail.

I highlight Heycock & Zamparelli (2005) because they are the most fully worked-out example of the collective theory of coordination. For example, Krifka (1990a) also adopts the collective theory of coordination and shows how to generalize it to various cases such as adjectives and relational nouns, but he does not say much about the semantics of noun-noun coordination. He only specifies sufficient but not necessary truth conditions for conjoined expressions. According to him, *cat and dog* will apply among other things to all sums of a cat and a dog, and "some pragmatic strengthening" tells us to remove those other things from consideration. His account does not specify when the pragmatic strengthening occurs, and does not generate the intersective interpretation. For a thorough technical discussion and criticism of the accounts by Hoeksema (1988) and Krifka (1990a) from the perspective of the intersective theory, see Winter (1998) and Winter (2001).

7.1 The collective theory: Heycock & Zamparelli (2005)

Heycock & Zamparelli (2005) defend the collective theory of *and*. They adopt the following collective entry for *and*, which is very similar to the one I have discussed in (11) in Section 2.1:

(101) $[\![\text{and}_{coll}]\!] = \lambda Q_{\langle \tau t,t\rangle} \lambda Q'_{\langle \tau t,t\rangle} \lambda P_{\tau t} \exists A_{\tau t} \exists B_{\tau t}.\ A \in Q \wedge B \in Q' \wedge P = A \cup B$

Essentially, this entry combines two sets of sets, called Q and Q' here, by computing their cross-product. But instead of putting any two elements together to form a pair, the entry forms their union. Heycock & Zamparelli (2005) call this operation *set product*. This treatment is somewhat similar to certain kinds of truthmaker semantics, as for example the systems in van Fraassen (1969) and in Fine (2012). The entry in (101) is assumed to be the one and only meaning for *and* in Heycock & Zamparelli (2005). That is, they assume that *and* always involves collective formation, and never involves intersection. Nouns and verb phrases are assumed to denote sets of singletons. For example, the noun *man* denotes the set of all singletons of men, $\lambda P.|P| = 1 \wedge P \subseteq \textbf{man}$. When the nouns *man* and *woman* are conjoined, the entry in (101) generates the following denotation:

(102) $[\![\text{man and}_{coll}\text{ woman}]\!]$
$= \lambda P_{et} \exists A_{et} \exists B_{et}.\ |A| = 1 \wedge A \subseteq \mathbf{man} \wedge |B| = 1 \wedge B \subseteq \mathbf{woman} \wedge P = A \cup B$
$= \lambda P_{et} \exists x \exists y.\ \mathbf{man}(x) \wedge \mathbf{woman}(y) \wedge P = \{x, y\}$

This denotation is equivalent to the one my system generates, as seen in (20e). In this respect, my system can be seen as a reconstruction of the one in Heycock & Zamparelli (2005) from first principles. But there is an important difference. I assume that all instances of *and* are intersective while Heycock & Zamparelli assume that all instances of *and* have the collective denotation in (101). In other words, Heycock & Zamparelli adopt a theory very close to the one showed in (11). That assumption leads to problems when quantifiers are conjoined that are not upward entailing, as in the following cases:

(103) a. No man and no woman smiled.
b. Mary and nobody else smiled.

Assume first, as Heycock & Zamparelli do, that the conjuncts in these examples are treated as generalized quantifiers, as shown in (104) for *no man.* (The unusual types are due to the assumption that nouns denote sets of singletons:)

(104) $[\![\text{no man}]\!] = \lambda Q_{\langle et,t \rangle}.\neg \exists X_{\langle et \rangle}.[\![\text{man}]\!](X) \wedge Q(X)$

Heycock & Zamparelli predict that the complex noun phrase in (103a) holds of the union of any set **A** containing no man and any set **B** containing no woman. As **A** may contain women and **B** may contain men, the resulting truth conditions are too weak. For example, (103a) is true in a model that contains a smiling man called John, a smiling woman called Mary, and no other smilers. This is for the following reason. The entry for *no man* in (104) holds of the set containing nothing but the singleton of Mary, since that set contains no man. The corresponding entry for *no woman* holds of the set containing nothing but the singleton of John since that set contains no woman. According to entry (101), the noun phrase in (103a) therefore holds of the union of these two sets, namely, the set containing nothing but the singletons of John and of Mary. But this set is precisely the denotation of *smiled* in this model. For analogous reasons, (103b) is predicted to be true in this model (assuming that *nobody else* in this context means *nobody other than Mary*).

Heycock & Zamparelli are aware of this problem and suggest that scope-splitting analyses of *nobody*, as proposed by Ladusaw (1992) and others for languages with negative concord, might help here. On these analyses, the lexical entry of *no* is separated into one part that contains only $\neg$ and another part that contains everything else including $\exists x$, and the negation part is free to take scope in a higher position than the rest. But adopting such an approach would wrongly predict that (103b) means the same as *It's not the case that Mary and someone else smiled.* That sentence, unlike (103b), is true when Mary did not smile but someone other than Mary smiled.

Conjunctions of non-upward-entailing quantifiers such as *no man and no woman* represent a challenge for the collective theory. While Heycock & Zamparelli (2005) provide many important empirical observations concerning coordination of nouns, they do not give a satisfying account of conjunctions of non-upward-entailing quantifiers. Moreover, it does not seem easy to extend the collective theory to these conjunctions, perhaps unless one is willing to radically rethink the meaning of quantified noun phrases. I will not do that in this paper.

7.2 Departing from the intersective theory: Winter (1995, 1998)

In this paper, I have built to a large extent on the theory in Winter (2001), which discusses coordination of noun phrases and of verb phrases but not coordination of nouns. In earlier work, Winter does discuss coordination of nouns and takes it to require a departure from the intersective theory of coordination (Winter, 1995, 1998, ch. 8). This approach has been recently revived by for the crosslinguistic analysis of certain particles like Japanese *mo* (Szabolcsi, 2013). These particles seem to be licensed by the presence of a covert conjunction or related notion.

For Winter (1995) and Winter (1998, ch. 8), *and* always returns the denotations of its two conjuncts as an ordered pair. For example, *man and woman* is translated as the ordered pair in (105).

(105) $[\![\text{man and woman}]\!] = \langle \lambda x.\mathbf{man}(x), \lambda x.\mathbf{woman}(x) \rangle$

When such a pair combines with other items in the tree, it is first propagated upwards in a style reminiscent of alternative semantics (e.g., Rooth, 1985). That is, the two computations proceed in parallel. At any point in the derivation, this ordered pair can be collapsed back into a single denotation by covert application of Intersection on its two members. If this operation happens immediately, it mimics the behavior of intersective *and*. But because the computation can proceed in parallel pairs, it becomes possible *and* to take arbitrarily wide scope. This leads to the right results in cases like (5), which is ambiguous between readings (5a) and (5b), repeated here for convenience (Winter, 1998):

(106) Every linguist and philosopher knows the Gödel Theorem.
  a. Everyone who is both a linguist and a philosopher knows the Gödel Theorem.
  b. Every linguist knows the Gödel Theorem, and every philosopher knows the Gödel Theorem.

In Winter's analysis of (106), if Intersection is introduced immediately, this leads to the reading in (106a). If it is introduced after the conjuncts have combined with the determiner and optionally with the verb phrase, the reading in (106b) is generated. On the present account, reading (106a) is obtained by Intersection, while reading (106b) is obtained by Raising, Intersection, Minimization, and Determiner Fitting.

However, the delayed introduction of intersection in Winter (1998) overgenerates. For example, the system does not prevent *No girl sang and danced* from meaning the same as *No girl sang and no girl danced.* This is shown by the following derivation:

(107) a. $[\![\text{no girl}]\!] = \lambda P.\neg\exists x[\mathbf{girl}(x) \wedge P(x)]$
  b. $[\![\text{sang and}_{pair}\text{ danced}]\!] = \langle \lambda x.\mathbf{sing}(x), \lambda x.\mathbf{dance}(x) \rangle$
  c. (107a)((107b)) = $\langle \neg\exists x[\mathbf{girl}(x) \wedge \mathbf{sing}(x)], \neg\exists x[\mathbf{girl}(x) \wedge \mathbf{dance}(x)] \rangle$
  d. Application of Intersection: $\neg\exists x[\mathbf{girl}(x) \wedge \mathbf{sing}(x)] \wedge \neg\exists x[\mathbf{girl}(x) \wedge \mathbf{dance}(x)]$ $= [\![\text{No girl sang and}_{pair}\text{ no girl danced}]\!]$

The problem here is similar to the one that arose for early accounts of verb phrase coordination in Transformational Grammar via conjunction reduction. By allowing the subject to enter the computation twice and by giving *and* scope over it, such accounts overgenerate in many cases where the subject is a quantifier. The system presented here avoids this problem since *and* is interpreted as local, not delayed, intersection. A sentence like *No girl sang and danced* is interpreted simply by intersecting *sang* and *danced* locally.

To be sure, intersecting *sang* and *danced* locally is also a possible derivation in Winter (1998). Both that system and the one I have presented in this paper must be prevented from overgenerating. In my case, for example, we need to prevent Existential Raising from applying to both *sang* and *danced*. For this reason, I assume that the distribution of silent operators is not free but is constrained by syntax, just like the distribution of ordinary words. This assumption is discussed and defended at length in Winter (2001).

Of course, one could adopt the system of Winter (1998) by constraining the application of Intersection syntactically as well, for example by requiring pairs to be collapsed at certain nodes including the one that dominates the verb phrase. For the purpose of Winter's approach and of this paper (that is, for the purpose of showing that the intersective theory is viable), one might of course just as well adopt the present system for noun-noun coordination. The departure from the intersective theory in Winter (1998) is possible but not necessary.

8 Summary and outlook

The intersective theory of *and* has been successfully applied to coordination of constituents other than nouns (Winter, 2001). But its application to coordination of nouns has remained elusive and has been taken to require a departure from the intersective theory (Winter, 1998; Heycock & Zamparelli, 2005). In this paper, I have shown that the intersective theory is not only viable in this case, but arguably preferable since it generalizes to other cases more successfully than the collective theory. The intersective theory straightforwardly delivers the observed behavior of *and* in cases like *liar and cheat*. The main result of this paper is that the intersective theory also predicts the collective behavior of *and* in noun-noun coordinations like *man and woman*, due to the way it interacts with silent operators previously postulated to account for phenomena involving indefinites and collective predicates (Winter, 2001). Essentially, this collective behavior has the same source as the behavior of *some man and some woman*, except that the instances of *some* are silent modifiers rather than overt determiners. Potentially non-disjoint sets, as in *doctor and lawyer*, have made it necessary to adopt a choice-functional analysis of the silent modifiers in question. Coordination of plural nouns, as in *five men and women*, are potentially ambiguous: in this case, there may be either ten or just five people in total. The former case can be dealt with by assuming a silent copy of the numeral, or by raising the type of the nouns before conjoining them so they expect the numeral as an argument. The latter case requires the application of a distributive choice-functional operator, which is independently motivated by exceptional scope of plural numerals that are interpreted distributively.

The hardest nut to crack for anyone wishing to pursue the collective theory is probably coordination of non-upward-entailing quantifiers such as *no man and no woman*. Not only do Heycock & Zamparelli (2005) not give a satisfying account of these conjunctions, it also does not seem easy to give one under *any* approach that takes the basic meaning of *and* to be collective. For this reason alone it seems preferable to make the intersective theory work if one is interested in using generalized quantifier denotations for at least some non-upward-entailing noun phrases.

The intersective theory of coordination suggests that there is a close relationship between *and* and *or* in natural language, analogous to the close relationship between intersection and union in many logics. Any set of assumptions surrounding an intersection-based entry for *and* need to be tested with respect to whether they interact correctly with a union-based entry for *or*. This is the case here. In particular, the present theory explains the typological observation that across languages, *or* is never – descriptively speaking – ambiguous between union-based and collective uses the way *and* tends to be ambiguous between intersection-based and collective uses.

The analysis in this paper leads to new challenges. As discussed in section 2.3, hydras involving noun-noun coordination find a natural explanation in the present system. Unfortunately, hydras have the well-known property that for each head cut off, three more need to be dealt with. Link discusses noun-phrase-headed hydras like the following:

(108) the boy and the girl who met yesterday

I see no straightforward way to analyze these kinds of hydras under any of the accounts discussed in this paper, including my own. The main problem seems to be how to compute the presuppositions of each of the two definite determiners. The presupposition of the first determiner seems to be that there is a unique boy who met yesterday with a girl, and the presupposition of the second determiner is analogous. Thus each determiner's restrictor appears in the presupposition of the other one. Perhaps an account of these facts can be given along the lines of Champollion & Sauerland (2010). I leave this problem open for future work.

Examples involving adjective conjunction such as *the flag(s) is/are green and white* are another interesting test case for theories of coordination (Krifka, 1990a; Winter, 2001). The present system can be extended to these examples as follows. First, we move to a mereological setting in which parts of ordinary objects, as well as pluralities of these objects, are explicitly represented as entities in the model. This is independently needed if we decide to pursue a unified analysis of mass terms and plurals (Link, 1983). The extension furthermore requires allowing Raising to apply to adjectives. The derivation of *green and white* proceeds similarly to that of *man and woman* but requires an extra step that applies to the output of Minimization and collapses each pair in this output into its mereological fusion. The result is that *green and white* denotes the set of all fusions of a green and a white entity, as desired. This extra step is required anyway if one chooses to adapt the present system as a whole into a setting where collective individuals are represented as mereological sums rather than sets. This would also be required if one wanted to extend the present treatment to mass noun conjunctions like *water and wine* in a mereological framework such as Link (1983). A challenge consists in preventing this approach to adjective conjunctions from overgenerating to cases like *#the bridge is long and short* without ruling out *the bridges are long and short* (Winter, 2001). Most long bridges can be divided into a long part and a short part, yet we cannot apply collective predicate coordination in this case.

I have not discussed overgeneration much in this paper, because my main goal was a proof of concept: I simply wanted to show that the intersective theory is able to generate the right collective readings in the first place. However, a well-motivated mechanism that prevents overgeneration would be an essential feature of any grammar or fragment that implements the system presented here. In the absence of such a mechanism, the only thing that prevents dropping a generalized quantifier into a nominal position (in which it would be interpreted as a property of sets) is the good will of the grammar user. For an illuminating discussion of the havoc that a mischievous grammar user who is granted unconstrained access could wreak to silent semantic operators like Raising and Minimization, see Winter & Schwarzschild (2001). A promising approach is to adopt the category-shifting strategy advocated in Winter (1998, 2001). According to this strategy, silent semantic operators change the semantic category of an expression (e.g. from predicate to quantifier and vice versa) and are triggered by the need to shift the syntactic category of a constituent, rather than by semantic type mismatch. This approach would require a more fine-grained view of syntactic categories than is usually assumed, since the Raising operation as used here maps nominals to other nominals. The fragment in Winter (2001, p. 186f.) is similar in this respect, since it contains D' constituents (complements of determiners) that are mapped to other D' constituents by minimizers and choice-functional operators. Furthermore, one may exploit the number agreement system of English to rule out expressions like **two man and woman* which are otherwise expected to be a good way to talk about a man and a woman.

The agreement properties of English noun-noun coordinations are highly interesting in their own right. Witness, for example, the singular determiner and the plural verb phrase in *this man and woman are in love*, and the contrast with the singular verb phrase in *Every cat and dog is licensed.* Agreement of noun-noun coordinations, both in English and across languages, are of central concern in King & Dalrymple (2004). Determiners and languages differ in whether they allow collective interpretations of singular noun coordinations. This seems to be due to the different ways in which determiners and languages interact with morphological agreement features and their semantic counterparts (Heycock & Zamparelli, 2005). A natural next step to take is to study the interaction of semantic system presented here with a grammar that describes number agreement in English and across languages. The grammar in King & Dalrymple (2004) seems to be a promising candidate for that purpose.

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