Review of: **Winter (**1998**) Flexible Boolean Semantics: Coordination, Plurality and Scope in Natural Language.**

Reviewed by**: Roger Schwarzschild, October 8, 1999**

Chapters 2 and 3 of this dissertation are largely based on previous work on conjunction (Winter 1996) and on the use of choice functions to explain apparent wide-scope indefinites (Winter 1997). In chapters 4 and 5 these two lines of investigation are drawn together in an interesting way. The result is a rich theory covering all three topics mentioned in the subtitle.

As explained in the abstract above, on Winter's view, *and*, even when collectively understood, has a meaning derived from propositional conjunction (so called boolean conjunction). Since propositions are elements of type t, I will call this view "t-only-conjunction". As is the nature of a rich system such as Winter's, decisions in one part can affect how things develop in another part and one can often understand the system by trying to tease the various strands apart. My goal here will be to look at some of the results in chapters 4 and 5 and to trace the effects of adopting t-only-conjunction. Somewhat surprisingly, in chapter 4 we will find that it has consequences in the syntax. In chapter 5, we will find that t-only-conjunction leads to a view of type-shifters as the locus of a lexical generalization in the area of generalized quantifier theory.

This is a marvelous dissertation chock-full of interesting analyses of various phenomena. I recommend it highly. I couldn't possibly say everything I'd like to about it in this short review.

1. Predicate-quantifier flexibility (Chapter 4)

In this chapter various "flexibility operations" are discussed. One of them, ε_{cf} , is a generalization of the choice-function approach to indefinites, allowing the functions to apply to various set denoting expressions, not just indefinites. Another operator, ε_{min}, is essentially a predicativizer. In a sense, it is a generalization of Partee (1987)'s BE operator. Finally, as we will see below, the composition of ε_{cf} with ε_{min} effectively yields the operation of Winter (1996) that produces a collective reading out of the conjunction of two generalized quantifier denoting names. There is a third operator whose exclusion here will not affect the main point. The chart below provides further details on these operators.

Null Element	Syntax	Meaning Operation	what it does	an example
ε_{min}	$D_p' \rightarrow \varepsilon_{min}\ D_q'$	min	takes a set of sets returns a set containing the smallest one	min(λP.P(j)) = {{j}}
ε_{cf}	$D_q' \rightarrow \varepsilon_{cf}\ D_p'$	<f>	applies a choice function f to a set S and gives the set of sets containing f(S). Exception: if S is empty, <f> is empty.	Let A= {j,k,l} Let f(A) = k <f>(A) = λP.P(k)

These operators are used in an analysis of the syntax of copular sentences in Hebrew, following discussion by Doron(1983). The central body of data revolves around the fact that the pronominal copula is obligatorily present in some cases but not in others. It must be present, for example, when followed by a name (1-2) but it may be omitted when followed by a bare indefinite (3):

1. ha-xavera haxi tova šeli hi Dana
the-friend most good mine copular-pronoun Dana
'My best friend is Dana'

2. *ha-xavera haxi tova šeli Dana
the-friend most good mine Dana
'My best friend is a Dana'

3. ha-xavera haxi tova šeli (hi) mora
the-friend most good mine (copular-pronoun) teacher
'My best friend is a teacher'

Winter's analysis begins by assigning names to the category of D'_q with meanings of type <<e,t>,t>, while definites and indefinites (without an *eize 'some'*) are treated as D'_p and denote sets of singularities or pluralities. Here is a set of sample denotations in a model where John and Mary are lawyers, John is the man and Mary is the woman:

expression	syntactic category	semantic type	meanings
John	D'_q	ett	$\lambda P.P(j)$
Mary and John	D'_q	ett	$\lambda P.P(m)$ & $P(j)$
the woman	D'_p	et	{m}
the lawyers	D'_p	ett	{ {j,m} }
a lawyer	D'_p	et	{j,m}

Simplifying a bit, syntactically the predicative position must contain an expression in D'_p and the copula is obligatory if an operator has applied in the formation of that expression (107,p192; expressions like *every man* are in DP_q and are therefore forbidden to appear in predicate position). This automatically guarantees that simple indefinites and definites can appear in predicative position without the copula. As for names, they are generated as D'_q so they could only appear in predicative position if the ε_{min} operator applied. The singular case is slightly more involved so let's look at the plural. If ε_{min} applies to the D'_q *Mary and John* we get a D'_p with exactly the meaning of *the lawyers.* This is a fine predicate but since an operator applied a copula is required, thus explaining data like in 2. This system derives a number of impressive results beyond just capturing the copula generalization stated so far. The first result has to do with Doron's observation "that when bare indefinites appear in copula-less predicative position they must be interpreted with narrowest scope" (p191). The sentence *Rina asked if Dani is a pianist whose name I had forgotten* has a wide-scope reading according to which Rina was asking about a particular pianist. If the sentence is translated without a copula, this reading is missing. In Winter's system, the choice function operator ε_{cf} is a tool for generating wide-scope indefinites. In other words, to get the wide-scope you need an operator, if you need an operator, you must have a copula. The operator analysis of obligatory copula explains another surprising fact. While the copula is not necessary when a simple indefinite is in predicative position, as in 3 above, it becomes necessary, according to Winter, with conjoined indefinites:

4. * štey ha-našim halalu soferet ve-mora
two-of the-women those author and-teacher
'those two women are an author and a teacher'

5. štey ha-našim halalu <u>hen</u> soferet ve-mora
two-of the-women those <u>pronoun-copula</u> author and-teacher
'those two women are an author and a teacher'

Even though it is possible to generate a D'_p from two indefinites without the aid of any operators, it turns out that to get the relevant reading of 5 operators must be used and this again predicts the obligatory presence of the copula.

Demonstrating why operators are needed here will give the reader a quick summary of much of chapters 2 and 4 of this dissertation. The story begins with the 'boolean' assumption that conjunction always denotes intersection. Now, if the meanings of the predicates *author* and *teacher* are simply intersected we get the set of individuals each of which is both an author and a teacher. But that is not the intended reading here. We are after a reading in which one of the women is an author and the other is a teacher. How can this be achieved in this system? Since (the Hebrew equivalents of) *an author* and *a teacher* are D'_p the ε_{min} operator is **syntactically** out of the question at this point. Instead we apply the ε_{cf} operator to each expression and we get:

$$\varepsilon_{cf} \text{ (an author)} \Rightarrow \lambda P[P(f(\text{author}'))]$$
$$\varepsilon_{cf} \text{ (a teacher)} \Rightarrow \lambda P[P(g(\text{teacher}'))]$$

Combining these with intersective conjunction we now get:

$$[\varepsilon_{cf} \text{ (an author) and } \varepsilon_{cf} \text{ (an teacher)}] \Rightarrow (\lambda P.P(f(\text{author}')) \cap \lambda P.P(g(\text{teacher}')))$$

$$= \lambda P.\ P(f(\text{author}'))\ \&\ P(g(\text{teacher}'))$$

Assuming for a moment that f picks Mary from among the authors and g picks John from among the teachers, this meaning is just the meaning of *Mary and John* given in the chart above. The expression is a D'_q because that is what ε_{cf} produces, so, as we did earlier, we apply ε_{min} to the result to get a D'_p. This gives us:

6. ε_{min} (ε_{cf} (an author) and ε_{cf} (an teacher)) = { {f(author') , g(teacher')}}

This is now a predicate that holds of just one plurality, which is fine for us. 5 now says that those two women are a plurality consisting of one author and one teacher (the function variables are freely existentially quantified in Winter's system). And again, we correctly predict that there should be a copula in this case because operators have applied.

The result in 6 is a predicate so if we wanted to use this in non-predicative position, we would have to apply ε_{cf} again. This would give us a generalized quantifier over the plurality, that is, a set of sets each containing the author-teacher plurality. This means that something very important has happened. Winter has successfully produced a collective reading for nominal conjunctions without departing from his assumption that *and* always means intersection (see below for why this would be desirable). The last step in which ε_{cf} is applied to a predicate to get a generalized quantifier is quite general and would be used to create subject phrases out of the other predicative expressions discussed above: *the lawyers, a teacher, the lawyer, the woman*, ε_{min} (*John and Mary*).

One final fact which is explained by this approach to copular constructions has to do with at-least/exactly readings of numeral indefinites like *two lawyers.* As an indefinite, *two lawyers* is interpreted as a set of pluralities, each plurality is a set of two lawyers. To say that those women over there are two lawyers is to say that the predicate *two lawyers* applies to the plurality of those women over there. This entails that there are exactly two women over there. One the other hand, if I want to use *two lawyers* in non-predicative position I have to use ε_{cf} . In this case, to say that two lawyers were sitting over there is to say that there is a plurality of two lawyers over there. This allows that there could be more lawyers. Thus, Winter's system accounts for the fact that numeral indefinites have an exactly reading in predicative position but not (necessarily) in non-predicative position.

This proposal has a semantic and a syntactic component unlike the proposal of Partee(1987), which forms the starting point for Winter's discussion. Whereas Partee relies on a semantic characterization of a predicative NP along with semantically driven type-shifting principles, Winter relies on syntax to define the predicative position and he uses null operators in the syntax. This last point is significant. These operators must be syntactically present both to regulate the kinds of phrases they apply to and the kinds of phrases they produce. If these operators applied freely, constrained only by the semantic type of their arguments, havoc would ensue, as the chart below demonstrates:

undesirable collocation	what it would mean	what prevents it
ε_{min} (*each man*)	the men	*each man* is not a D'_p
ε_{cf} (*each man*)	the men by themselves or with others	*each man* is not a D'_q
[ε_{min} (*John*)] *left*	only John left.	[ε_{min} (*John*)] is D'_p, subjects are D'_q
[ε_{cf} (*John*)] *paid $100*	John by himself or with others paid $100	*John* is a D'_q, ε_{cf} applies to D'_p

[*the boys*] *left*	only the boys left	*the boys* is a D'_p, subjects are D'_q

The presence of these syntactic structures raises a number of questions. Is there independent motivation for the different kinds of D'? Is there syntactic evidence for the null operators? Are they overt in any language? If they were, then, for example, wide-scope indefinites would look different than narrow scope ones and conjoined NPs would look different and more complex when collectively interpreted than when distributively interpreted. We might also expect to find further syntactic restrictions on the use of these operators translating into syntactic constraints on the presence of collective readings (Winter's neat discussion of *both…and* p183-4 seems to point in this direction). Since the syntactic differences between D'_p and D'_q (not to mention a third category D'_-) do not correlate with semantic type, could we expect a language where the syntactic categories are reversed, that is, a language where *John* is a D'_p and where *the boys* is a D'_q ?

Perhaps the most important point here is that this syntactic machinery turns out to be a fairly direct result of Winter's analysis of collective conjunction. Hence an argument for or against the syntax counts as an argument for or against that analysis. This is a rather surprising result which bears elaboration. Winter's method for collective conjunction relies on the fact that at the 'bottom' of a quantifier like $\lambda P[P(m) \& P(j)]$ lies a set, {j,m}. To capitalize on this fact (a) we need an operation that applies to quantifiers and (b) we need to identify pluralities with sets, more generally, a plurality has to be identified with a **predicate** meaning. Each of the problematic collocations in the chart above can be traced to one or both of these assumptions. What this means is that one should in principle be able to pick and choose here, keeping Winter's striking analysis of the copula, without adopting t-only-conjunction. Here's a sketch of what Winter's analysis might look like without t-only-conjunction:

> Pluralities are members of the domain of entities.
>
> Names are uniformly type e expressions, definites and indefinites are uniformly type <e,t>
>
> *and*$_{\langle\langle e,e\rangle,e\rangle}$ denotes plurality formation, indicated with a + (Link 1983).
>
> Optional choice function operators apply to expressions of type <et> to produce expressions of type e with no reflex in the syntax. (§ 3.5, and possible objections in §3.4.1, §3.4.2)
>
> **Q** is an e → <e,t> type-shifter: **Q** = $\lambda x.\{x\}$ (p.146)
>
> Predicative positions are uniformly type <e,t>. (Partee 1987).
>
> In Hebrew, the pronominal copula is obligatory only if **Q** has applied.

The facts discussed above all follow on this system. Names need a copula because they require the use of Q. Wide-scope indefinites need a choice function and that produces type-e meanings so that again Q is pressed into service and the copula becomes obligatory. Q also becomes necessary to achieve the intended reading of the predicate *be a teacher and an author*:

$$Q(f(⟦\textit{author}⟧) + g(⟦\textit{teacher}⟧))$$

The exactly reading of predicative NPs follows in the same way. Expressions like *every boy* are excluded from predicate position for type reasons.

In §2.3.7 there are a number of reasons for adopting the t-only-conjunction view, and the above system doesn't necessarily answer these. However, there is one initially rather persuasive argument for t-only-conjunction which is worth revisiting now. Winter's method for arriving at collective conjunction correctly produces the collective reading of the *and* in (62) repeated below, according to which it entails (63):

(62) Mary and (either) [Sue or John] met.

(63) Mary and Sue met or Mary and John met.

The claim in chapter 2 is that collective *and* in type <<e,e>,e> is no match for the disjunctive *Sue or John*. However once we learn about choice functions the argument weakens. The "Winter minus t-only-conjunction" system sketched above assigns the subject of (62) the meaning in 7:

7. $m + f(Q(s) \cup Q(j)) = m + f(\{s,j\})$

Here we capitalize on Winter's discovery (p175) that the choice function mechanism allows "disjunction to 'take scope' over the collectivization process". Depending on what individual f chooses from {s,j}, either Mary met with Sue or she met with John, as (63) claims.

A result of separating t-only-conjunction from the rest of Winter's system is that barring any type-shifting operations, names denote in type e rather than Winter's <<et>,t>. This means that we should **not** expect NP-based distributivity for name conjunctions. While there are potential objections to such a move in §6.1.3, there may be arguments in its favor outside of simplicity. With NP based distributivity excluded, the locus of distributivity will always be in the predicate. A potential argument for such a setup might develop from cases in which for a given NP subject, distributivity is possible for some predicates but not for others. The examples in 8-11 afford us such a case. While 8 cannot mean 9, 10 can mean 11.

8. Bill Clinton and Al Gore are the President or the Vice President.
9. Bill Clinton is the President or the Vice President and Al Gore is the President or the Vice President.

10. Bill Clinton and Al Gore weigh over 150 lbs.

11. Bill Clinton weighs over 150lbs and Al Gore weighs over 150lbs.

2. Plural quantification (chapter 5)

A centerpiece of chapter 5 is the analysis of plural quantificational noun phrases such as *exactly 2 ducks*. Winter has cleverly combined insights from Scha and van der Does into a single type-shifter dfitw, which operates on determiner meanings. The penultimate proposal ((65)p230, (109),p244—final version: (123)p249) is repeated below:

$$\text{dfitw}(D) = \lambda A\, \lambda B.D(\cup A)(\cup(A \cap B)) \;\&\; [A \cap B \neq \varnothing \rightarrow \exists W \in A \cap B[D(\cup A)(W)]]$$

dfitw has three main features. First, it incorporates the idea that quantification always 'counts' singularities, never pluralities. *exactly 2 ducks* counts two individual ducks and not two duck pluralities. This is the reason for all the union symbols. The next feature has to do with the existential in the consequent of the conditional. Winter (p243) finds it false or highly marked to say:

(107) Exactly 5 students drank a glass of beer together.

to describe a situation where three students drank one beer together and two other students drank a second beer. In this situation there are exactly 5 cooperating beer drinking students, so the first conjunct will hold true:

[exactly-5](∪[students'])(∪(students' ∩ drink-a-beer-together'))

But there is **no** group of five students that drank together and that is what the consequent of the conditional requires. Finally, the effect of the antecedent of the conditional is to nullify this requirement when the quantifier is monotone decreasing, unlike in previous analyses (though see Nerbonne 1995). We do not, for example, want to give existential import to a noun phrase like *no boys*. I assume Winter also had in mind universal cases. This formulation allows *all the boys drank together* to be vacuously true if there are no boys.

I'd like to focus on the status of dfitw as a type-shifter. The motivation for the type-shifting mechanism can be appreciated in the context of the following two examples:

(94) All the committees reached a decision together last week.
(95) Every committee reached a decision together last week.

According to Winter, (94) has two readings which correlate with an ambiguity he posits in the meaning of plural nouns. On one reading, (94) is synonymous with (95). This reading is explained by taking *all* and *every* to have the same meaning and allowing that a plural noun has the meaning of the corresponding singular (ignore the definite article in (94)). On the second reading of (94), the committees meet with each other. This reading is achieved by applying dfitw to the meaning of *all* and then combining it with the other meaning of *committees*, a set of sets of committees. I will symbolize this second meaning of *committees* with Winter's operator **pdist** which just forms the power set minus the empty set:

12. dfitw(all')(pdist-committee')(reach a decision together')

Assuming there are committees, 12 requires the plurality consisting of all the committees to be in the extension of *reach a decision together.* dfitw comes in to shift the type of the determiner when its argument is semantically plural.

I use the term "semantically plural" because this shift really only cares about semantics and doesn't help or hinder the syntax. Since diftw is a type-shifter it would apply if *every* combined with plural nouns, but English syntax disallows that. And, since *every* and *all* have the same meaning, *all* could be combined with the meaning of a singular noun if only the syntax allowed the combination. This is all to say that the syntax of determiners is completely irrelevant to dfitw.

Whereas in Scha and van der Does' analyses, there are several shifts leading to an ambiguity in the meanings of plural determiners, Winter has collapsed them into one, leading to what appears to be a univocal meaning. In this regard, it is interesting to note that diftw could easily be modified so as to be applicable to any determiner, regardless of what the semantics of its arguments is. Instead of extracting singularities using the union operator, we can use the operator defined below:

$$\underline{\cup}A = \{x: x \in A \text{ or } \exists W \in A: x \in W\}$$

Making this substitution and modifying the antecedent of the conditional in dfitw slightly we arrive at:

$$\underline{\text{dfitw}}(D) = \lambda A\, \lambda B.D(\underline{\cup}A)(\underline{\cup}(A \cap B))\ \&\ [(\exists W \in A \cap B) \rightarrow \exists W \in A \cap B[D(\cup A)(W)]]$$

This operation can apply now to all quantifiers. If A,B contain only singularities, then the conditional becomes trivially true (W is a variable over pluralities) and $\underline{\cup}$ is harmless. If A,B contain pluralities, $\underline{\cup}$ amounts to $\cup$, and the antecedent of the conditional says what it said before. Since dfitw applies in all cases, we might wonder whether it really should be implemented as type-shifter at all. Could we not just view dfitw as general fact about the true meanings of determiners? For example, could we just say that universals like *every* or *all* simply denote the relation dfitw(D) where D is just the subset relation and *exactly 2* just means dfitw(2!) where 2! relates two sets just in case the cardinality of their intersection is 2? This question leads us right back to t-only-conjunction. Winter's method for achieving collective conjunction depends on the fact that pluralities are the same type as predicate meanings. This means that semantically plural common nouns denote in a different type from singular ones, hence a type-shifter is needed to allow a determiner meaning to combine with both singular and plural nouns. On the other hand, if we allowed that pluralities and singularities were the same type of thing, we actually couldn't have a **type**-shift here.

At this point, we've drawn a line from the Winter's implementation of t-only-conjunction through to the status of dfitw as a type-shifter. Here are some considerations for addressing that issue. Should the use of type shifting be restricted? If so how? Partee(1987) talks about 'natural type shifts'. Is dfitw natural? Another issue stems from the fact that dfitw applies to a whole class of lexical items and doesn't have to apply within the course of derivation. Is it correct to use type-shifters to express these lexical generalizations? For comparison, consider van Benthem's(1984, 446) observation that "the behaviour of Q is completely specified by the couples of cardinalities (a,b), with $a = |A\text{-}B|$, $b=|A \cap B|$, for all E, A, B such that $Q_E AB$" . Should we capture this generalization by letting determiners denote relations between numbers and have a type shifter that takes their syntactic arguments and delivers $|A\text{-}B|$ and $|A \cap B|$?

These are very big questions and we aren't about to settle them here. The main conclusion I'd like to draw from dfitw is that the explanatory value of Winter's proposal is not diminished by removing it from the t-only-conjunction setting and that doing so has important consequences.

Finally, it is important to see that the issue of the status of dfitw is orthogonal to the other part of the chapter 5 proposal. In a nutshell, Winter claims that while both *gather* and *be a team* can be predicated of plural DPs like *the girls*, *gather* is +S and has pluralities in its extension while *be a team* is -S and has only singularities in its extension, though these singularities are teams. Assume the girls are team that gathered in the park. This means that the girl team is in the extension of *be a team* and the plurality of its members are in the extension of *gather*. The following holds (girl' is the set of girls):

girl' $\cap$ be-a-team' = $\emptyset$ pdist-girl' $\cap$ be-a-team' = $\emptyset$

girl' $\cap$ gather' = $\emptyset$ pdist-girl' $\cap$ gather' $\neq \emptyset$

These equations explain the judgements in (13) and (14) of Winter's discussion above, even if dfitw is part of the meaning of any determiner. The judgement in (15) relies on an independent and special treatment of the plural definite.

3. The Boolean Viewpoint

In Winter's summary, it is explained that the coordinators *and* and *or* denote the boolean operators meet and join in various domains. It is then pointed out that problems arise with collectives such as (8) *John and Mary met*. "The standard boolean treatment incorrectly predicts (8) to be equivalent to the unacceptable sentence *Mary met and John met*." This is so because the standard boolean treatment applies only to domains of type t or those derived from type t. This entails a treatment of *John and Mary* as in the chart given earlier.

But the algebraic perspective allows for a different picture of how *and* works according to which there is no problem with collectives. On this view *and* simply denotes one of the boolean operators, regardless of whether or not the domain is 't-based'.

This picture should of course be sketched in such a way that it is the same operator in all domains.

When defined, join and meet are operations over partially ordered sets. Consider then the following plausible orderings (read $\geq$ as "is greater than or equal to"):

Propositions:	$p \geq q$ iff: p entails q
Properties:	$P \geq Q$ iff: having P entails having Q
Entities:	$x \geq y$ iff x includes y

The intuition behind these orderings can be appreciated by thinking about more or less ordinary uses of *include*:

Propositions:	John's erasing his last sentence *included* John's erasing some of the words in his last sentence.
Properties:	walking *includes* leg-moving
Entities:	the American Presidents *include* Bill Clinton

For any domain with elements a and b where meets and joins exist we have:

meet(a,b) = the greatest element c such that: $a \geq c$ and $b \geq c$
join(a,b) = the smallest element c such that: $c \geq a$ and $c \geq b$

Intuitively, meet(a,b) gets you minimally at or below a and b, join(a,b) gets you minimally at or above a and b. Working through a few examples, one finds that *and* corresponds pretty closely to join in all three of the domains listed above. For example, if we take the properties of walking and riding and join them, we get a property that entails both walking and riding, that is, the property denoted by *walking and riding*. And if we join John and Mary we get the plurality which includes the two of them. That plurality can perform collective acts that neither of its members performs.

Winter reports that Payne has observed that no language was found where *or* shows "non-boolean" behavior. This leads us to wonder what the status of *or* is on the picture just sketched. In t-based domains, *or* denotes meet, but not in the domain of entities. To some extent this makes sense. For any two propositions, there is a proposition that both of them entails, but for many pairs of entities, for example John and Mary, there is no entity that both of them includes. But this will not explain everything. Even if John is included in the doctors and the lawyers, we cannot refer to him with *the doctors or the lawyers*. We are left then with the puzzle of why *or* cannot denote meet in a domain where meet is <u>partially</u> defined. But I don't see that this puzzle is particular to the view outlined here. It arises as soon as we posit that *or* denotes a boolean operator and go on to ascribe to the entity domain a structure on which such operations are defined.

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