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COMPARATIVES, SUPERLATIVES, AND RESOLUTION

1. INTRODUCTION

This paper will present an analysis of comparatives and superlatives geared to deal uniformly with certain kinds of ambiguities common to both constructions, especially focus ambiguities and strict/sloppy identity ambiguities. The analysis will also address some differences between the two constructions, such as the differing scoping possibilities of the measure quantifier.

The relevant ambiguities of comparative and superlatives will be analyzed through an intermediary: A single underspecified semantics for each sentence will be resolved in certain very constrained ways to give the various readings. The use of underspecified semantics to capture ambiguities has had particular appeal to those with a computational perspective. I argue here, however, that there is an important theoretical motivation for taking this road as well. It unburdens the compositional semantics. Much of the complexity is factored into machinery that will generally be necesssary for dealing with ellipsis and focus. Other than that, comparative adjectives are like other adjectives: comparative determines like other determiners.

This division of labor is in some sense the motivation for the hypothesis of a Logical Form (or LF) that plays a central role in semantic interpretation. Although there are some exceptions, scope relations cannot in general be read off surface syntax. Furthermore, studies of quantificational adverbs and of focus formatives like *only*, *also*, and *before* have shown that not only the scopes but also the domain sets of certain quantifications are underdetermined by the surface syntax. This does not mean that the surface syntax does not contribute a great deal. It does; at the very least an array of predicates and role assignments. It just means that much more than this needs to be done, much of it apparently related to the structure of quantification. In this paper when I refer to *compositional* semantics I will mean that part of semantics that can be read off the surface syntax. This part of the semantics of comparatives and superlatives is the part which I think is relatively straightforward.

Perhaps a better way to put this is to say that semantics of comparatives and superlatives ought to fall out from the interaction of three things:

1. The compositional semantics of determiners and adjectives.
2. The *special* (but simple) compositional semantics for comparatives and superlatives (which makes no reference to any non-compositional phenenomena, such as focus or ellipsis).
3. A separate non-compositional account of focus. In this paper I will deal only with comparative ellipsis, where the remnant in the *than*-phrase is a single NP constituent, and not with the full range of elliptical remnants that occur in *than*-phrases with comparatives, but I do not forsee any problems of principle in extending the approach taken here.

A related point concerns comparatives. The compositional semantics should be able to assign a single semantics to a main clause such as

(1)   Jean gave her sister a more expensive book.

whether it occurs in isolation in a discourse or is followed by a *than*-phrase with arbitrary elliptical fragments. What is missing is some property of degrees predicated of the degree of expensiveness of the book Jean gave Carol. This may be filled in by *than*-phrase (although it is often filled in only elliptically) or by knowledge of the preceding discourse. Both are matters independent of the semantics of (1). If a *than*-phrase comes along, the compositional semantics will tell us that it provides the needed property of degrees, although if the *than*-phase is elliptical it may not be able to tell us *which* property.

The particular resolution mechanism adopted for the underspecified semantics comes from Dalrymple, Shieber, and Pereira (1991) (henceforth DSP). That paper, dealing primarily with verb-phrase ellipsis,[1] uses higher order unification for ellipsis resolution.

The analysis here focuses on relieving the compositional semantics of any special burden concerned with comparative ellipsis. The equation-solving machinery will be responsible for blocking certain kinds of failures of parallelism that the compositional semantics alone allows. In particular differences in the behavior of degree and quantity comparatives and superlatives will be predicted, as well as constraints on what is called the *scope of comparison* in comparative ellipses constructions. The relevant facts are set out in Section 3.

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[1] In independent work, Pulman (1991) also proposes applying the DSP framework to comparative ellipsis. The details of the analysis are different, but the approach is very much in the spirit of what is argued here. A variety of data lead him to suggest extending the equational machinery to focus in Pulman (1992).

2. PARALLELISMS BETWEEN COMPARATIVES AND SUPERLATIVES

A major challenge to any proposal for a semantics of comparatives is to provide an analysis that captures the similarities between comparative ellipsis and superlatives. In particular, the kinds of ambiguity that show up in comparatives and superlatives correlate systematically. The following preliminary discussion tries to set some of the regularities a uniform analysis should capture.

I will use the term *comparative ellipsis* to refer to sentences like the following:

(2)   Jean gave Betty a more expensive present than Carol.

which has interpretations that are elliptical for either of the following:

(3)a.   Jean gave Betty a more expensive present than Carol gave Betty.

   b.   Jean gave Betty a more expensive present than Jean gave Carol.

In (3a) Jean is being compared with Carol with regard to the expensiveness of her present to Betty. In (3b) Betty is being compared with Carol with regard to the expensiveness of her present from Carol. I will say that for reading (3a) the NP *Jean* is the focus and *Carol* the contrast; for (3b) the NP *Betty* is the focus.

There are two reasons for calling NPs like *Jean* the focus when (2) is given reading (3a): one is that when the sentence is given this reading it is natural to give *Jean* a kind of intonational prominence characteristically associated with focused NPs; another is that the semantics of the comparative construction is entirely compatible with the kind of semantics associated with focus. Rooth (1992) discusses the interaction of his theory of focus specifically with cases of comparative ellipsis. On his account, focusing *Jean* in (2) presupposes the existence of another proposition of the form *x gave Betty a y expensive present*; on the relevant interpretation, the elliptical *than*-clause introduces a proposition of just this form, in which *x* is equal to Carol. This contrastive account of the two clauses in the elliptical construction is possible because the semantics of the main clause and the *than*-clause are parallel, differing only where the focus and its contrast differ.

But calling *Jean* the focus when (2) is given reading (3a) opens up the difficult question of how the analysis of ellipsis in sentences like these interacts with the general theory of focus. One might, on one hand, expect the theory of focus to do all or part of the work in resolving the ellipsis

of (2); one might on the other hand, only expect the theory of focus to acount only for the correlation of certain intonational and presuppositional facts about (2) with reading (3a), as Rooth suggests in Rooth (1992), and rely on a separate theory of ellipsis to account for the asserted semantics. I will suggest in the Appendix that the theories of focus and ellipsis need not be orthogonal, and that a natural account of ellipsis follows from the constraints imposed by the theory of focus, taken together with a theory of parallelism. In fact, the higher-order equations used here can be thought of simply as statements of the constraints jointly imposed by the theories of focus and parallelism, and Higher Order Unification (HOU) simply as a device for computing the interpretations compatible with the theory of focus.

The superlative sentence with which to compare (2) is:

(4)   Jean gave Betty the most expensive present.

This sentence exhibits an ambiguity analogous to that of (2). There are two readings which can be paraphased:

(5) a.   Jean gave Betty a more expensive present than anyone other
           than Jean gave Betty.
    b.   Jean gave Betty a more expensive present than Jean gave any-
           one other than Betty.

Again, I will call *Jean* the focus when (4) is given reading (5a). Again the intonational facts agree with this choice, and as we shall see when we turn to the semantics of superlatives, the semantics of the superlative construction are quite parallel to that of the comparative construction.

In addition to ambiguities of focus, superlative and comparative sentences share ambiguities involving strict and sloppy identity. Consider:

(6)   Jean gave her sister a more expensive present than Carol.

With the pronoun *her* understood as coreferential to the NP *Jean*, the following readings are possible:[2]

(7)   1. [Her sister]$_F$: Jean gave Jean's sister a more expensive book
           than Jean gave Carol.

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[2] It is well known that ellipsis constructions exhibit strict-sloppy ambiguities, as first noted in Ross 1967: As an example, consider uses of (i) in which the pronoun *his* is anaphoric to John:

(i)   John saw his sister and Bill did too.

Two kinds of interpretation are possible. One the so-called strict reading, Bill saw John's sister: on the sloppy reading, Bill saw his own sister.

>   2. [Jean]$_F$(strict): Jean gave Jean's sister a more expensive book than Carol gave Jean's sister.
>   3. [Jean]$_F$(sloppy): Jean gave Jean's sister a more expensive book than Carol gave Carol's sister.

I use the "F" subscript to index the focused NP. Now consider the variants in (8), which have analogous interpretations:

(8)   Jean gave her sister the most expensive book.

(9)   1. [Her sister]$_F$: of all x's such that Jean gave x books, Jean gave Jean's sister the most expensive book.

>   2. [Jean]$_F$(strict): of all x's such that x gave Jean's sister books, Jean gave Jean's sister the most expensive book.
>   3. [Jean]$_F$(sloppy): of all x's such that x gave x's sister books, Jean gave Jean's sister the most expensive book.

I will use the term *contrast-set* to describe the set of entities whose properties are being measured and compared, a set that always includes the denotation of the focus. In the paraphrases above, the contrast-set is described by the *of*-phrase.

I call the nonelliptical focus constructions in (8) maximal-measure constructions (rather than superlative constructions) because they come with both comparative and superlative morphology. Thus, beside (8) we have:

(10)   Jean gave her sister the more expensive book.

This has exactly the same readings except that, possibly, the contrast-set is presupposed to have two members in (10). Even this is probably a defeasible implicature rather than part of the semantics. Thus, the so-called "superlative" semantics, a universal quantification over a contrast set, correlates not with superlative morphology but rather with the definiteness of the NP containing the adjective. We will show below that for adjectives not occurring in NPs and not accompanied by a *than*-phrase, either superlative or comparative readings are possible.

Sentence (8) has another reading with no parallel in (6). This is the reading on which no givings are presupposed. There is simply a set of books available in the discourse, and Jean has given her sister the most expensive. The kind of comparative that parallels this is shown in (11):

(11)   Jean gave her sister a more expensive book than *War and Peace*.

Here, too, only one giving event is at issue. What is being compared is

the expense of the book in that giving event with the expensive of *War and Peace*.

Comparatives like (11) are not obviously elliptical, but I will show below that they can be analyzed using exactly the same equational machinery as the elliptical comparatives, and that the analysis of one reading of the superlative (8) goes along the same lines. Let us call the minimal NP containing the comparative element the *comparative NP* in comparatives and the *superlative* NP in superlatives. In the case of (11), a degree associated with the referent of the *than*-phrase is being compared with a degree associated with the referent of the comparative NP; in (8), a degree associated with the referent of the superlative NP is being compared to degrees associated with a known set of entities.

In the analysis of comparatives and superlatives to follow, I will use the term focus rather loosely to mean a parallel element of the comparison.[3] It will be a fixed property of comparative and superlative constructions that the degree will always be focused (always be a parallel element in the comparison), but in one reading of (8) and (11) nothing *else* will be focused. I will thus distinguish these cases by calling them *degree-focus* comparatives and superlatives.

The mere existence of strict/sloppy ambiguities in superlative sentences argues neither for an ellipsis analysis nor a focus analysis. It is well-known that focus constructions and ellipsis constructions both exhibit strict/sloppy ambiguities. Consider the ambiguity of (12), limiting our attention, again, to uses in which the pronoun *his* is anaphoric to the subject:

(12)   Only [John]$_F$ saw his sister.

Here a speaker might be claiming that only John had the property of seeing John's sister (the strict reading); or she might be claiming that only John had the property of seeing his own sister (the sloppy reading), in which case any number of people may have seen John's sister.[4]

The natural place to look for an account of strict/sloppy ambiguities in comparative ellipsis constructions is the theory of ellipsis; the natural place to look for them in superlatives is the theory of focus. The fact that these ambiguities show up in closely related constructions like superlatives and comparatives makes this an excellent test case for studying the relationship between the theories of focus and ellipsis.

In this paper, however, I will limit myself to showing that a single

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[3] Some justification for this usage is offered in the Appendix.

[4] The fact that *only* can generate bound-variable readings was first noticed by Geach (1962).

interpretative device, the HOU equational account, will unburden the compositional semantics and offer an account of both construction-types.

My strategy in what follows will be to first apply HOU to the analysis of Comparative Ellipsis (Section 4.1) and show how it accounts for the semantics: I then show how to extend the account to superlatives (Section 6). As a preliminary Section 3 will lay out the set of semantic problems the analysis is intended to address.

3. Facts to be Accounted For

3.1. *Maximal Measure Constructions*

I turn now to some observations on maximal-measure constructions. Thus far, we have only seen examples of maximal-measure constructions with adjectival superlatives. They also come with numerical and mass superlatives:

(13) a.   John bought the most sandwiches.
     b.   John ate the most food.

I will generally distinguish the numerical and mass cases from the adjectival cases, for reasons to be made clear later. I will call adjectival measures *degrees* and numerical and mass measures *quantities*. Thus (13) gives examples of maximal-quantity constructions, (8) of maximal-degree constructions. The two classes together exhaust the maximal-measure constructions. Analogously I will distinguish between degree and quantity comparatives.

The comparative interpretation goes only with comparative forms, but given a comparative form the constraints that determine when a maximal-measure interpretation is possible are problematic. One cue is the choice between the definite and the indefinite article:

(14) a.   John bought a more expensive ring.
     b.   John bought the more expensive ring.

Here, (a) is a discourse-bound comparative. The discourse must provide some item whose expense is in question. In (b) there is a set of two rings whose cost is in question, and John bought the costlier. Neither ring has to be available in the discourse, but the set does.

One syntactic diagnostic for a sentence requiring a maximal-degree interpretation is that a *than*-phrase is no longer possible:

(15) a.   John bought a more expensive ring than Mary.
     b.   *John bought the more expensive ring than Mary.

When neither the definite article nor the indefinite article is present, lone comparative adjectives can still get the maximal measure reading. Consider:

(16) a.   Who's taller?
      b.   Is John or Bill taller?

The sentences in (16) might be uttered in two different sorts of contexts:

(17) a.   If the center is not the tallest player, then who's taller?
      a'. If the center is not the tallest player, is Bird or Magic taller?
      b.   Bird and Magic weigh the same. Who's taller?
      b'. Bird and Magic weight the same. Is Bird or Magic taller?

In (a), the question is which member of the team under discussion is taller than the center, in (a') whether Bird or Magic is taller than the center. These are discourse-bound comparatives. In the (b) sentences, the discourse provides a contrast-set and the question is who in that set has the maximum height. With a set that has cardinality two, the comparative form of the adjective is encouraged. The second sentences in (17b) and (17b') might be replaced with any of the following:

(18) a.   Of the two, who's taller?
      b.   Who's taller, Bird or Magic?

Both of these unambiguously call for a maximal-measure interpretation.
  Consider, finally, the simplest case:

(19)   Bird is taller.

In principle, I see no reason why the grammar should exclude a maximal measure interpretation in this case, that is, an interpretation on which Bird is the tallest member of a given contrast set, a set which may just include Bird and Magic. The reason that there is no perceptible ambiguity in cases like these is that the comparative morphology seems to favor an interpretation on which the contrast set has cardinality 2, and this precludes any possibility of a truth-conditional distinction between the comparative and the maximal-measure readings.

3.2. *Ambiguities of Scope of Comparison*

We have observed two kinds of ambiguity associated with comparative and maximal measure constructions, ambiguities of focus and strict-sloppy ambiguities. These constructions show another dimension of semantic

variability generating a third kind of ambiguity, which I will call an ambiguity of *scope of comparison*.

Consider a sentence like:

(20)   California voters have been required to decide more ballot measures than Nevada voters.

Sentence (20) can be paraphrased either with (21a) or (21b):

(21)a.   It is required that California voters decide more ballot issues than it is required that Nevada voters decide.

     b.   It is required that California voters decide more ballot issues than Nevada voters decide.

Here the amount of semantic material included in the propositions being compared varies. Specifically in (a), which we can call the wide-scope reading, the comparison is between the number of ballot issues voters in California and Nevada are *required to decide* and in (b), between the number of ballot issues voters in California and Nevada *decide* the narrow-scope reading, it's not requirements being compared, but numbers of ballot issues; the requirement is that that comparison come out a certain way, in favor of the Californians.[5] We call this kind of ambiguity an ambiguity in the scope of comparison. We will get precise about what sort of scope this is when we present the semantics for comparatives in the next section.

Next consider a superlative example:

(22)   California voters are required to decide the most ballot issues.

An analogous ambiguity arises:

(23)a.   It is required that California voters decide more ballot issues than it is required that anyone else to decide.

     b.   It is required that California voters decide more ballot issues than anyone else decides.

There is a difference between (21) and (23) in these cases; the attachment of the *than*-phrase gives the comparative construction a syntactic way of *fixing* the scope of ellipsis. Consider the following:

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[5] Paraphrase (b) here actually collapses two distinct *de re* and *de dicto* readings; on the *de dicto* reading what is required is that whatever the number of ballot issues decided by Nevadans, California voters outdecide them; on the *de re* reading what is required is that Californian voters decide more than n ballot issues, where n is the number of ballot issues actually decided by Nevadans. This orthogonal ambiguity does not affect the point under discussion.

(24)   California voters have been required to decide more measures
        than Nevada voters by June.

Sentence (24) has only the unlikely narrow-scope reading: What is re-
quired that by June California voters have more ballot issues decided than
their Nevada peers have decided. Note that for semantic reasons the
modifier *by June* must attach low. What appears to be going on is that
when the *than*-phrase is forced to attach low the scope of comparison
must be narrow:

> [vp required to [[vp decide more measures][than Nevada vot-
> ers][by June.]]]

In light of this evidence, we propose Hypothesis A:

> **Hypothesis A** (Scope-Bounding Version)
> The scope of comparison can be no wider than the attachment
> site of the *than*-phrase.

The simple picture of comparative ellipsis is this: There is a relation
between an individual and a measure and the measure-values of the re-
lation are compared for the focus and the contrast.

   In being governed by something like Hypothesis A, comparative ellipsis
sentences with *than* are unlike other elliptical variants and like sentences
with *only*. Scope-fixing effects with *only* are discussed in Taglicht (1984)
and Rooth (1985):

(25)a. They were advised to only learn Spanish.
    b. They were only advised to learn Spanish.
    c. California voters have been required to decide more measures
        than Nevada voters have by June.

Here (a) has the reading on which advice is given to ignore languages
other than Spanish: (b) has the reading on which the only advice given
was to learn Spanish. The (a) sentence lacks the reading available for the
(b) sentence, and vice versa.[6] Thus, syntactic attachment of *only* fixes the
scope of the focus prediction, just as the syntactic attachment of the
than-phrase fixes the scope of comparison. The sentences in (25) are
unambiguous only by a syntactic accident. The word *only* attaches verb-
phrase initially so that it is clear which verb-phrase it has chosen; the

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[6] An anonymous referee reports that (25b) actually does have the reading of (25a). This
actually makes the scope-fixing properties of *only* more like those *than*-phrases in the analysis
to follow. The attachment-site puts an upper bound on the scope of the focus operator, but
no lower bound.

than-phrase attaches verb-phrase finally, so that sentences like those in (23) may be ambiguous.

In contrast, (25), a VP-ellipsis analogue of (24), suggests that some elliptical constructions fail to obey Hypothesis A: Both readings are possible.

Some facts described in Bresnan (1973) actually suggest that Comparative Ellipsis may be governed by something stronger than Hypothesis A:

(26)a.   A stronger man than John was found.
   b.   ?A stronger man than Mary was found.
   c.   A man stronger than John was found.
   d.   A man stronger than Mary was found.

Suppose for now that all of the NPs in (26) are elliptical. Suppose further that the scope of comparison in each case is not upper-bounded by how much material is C-commanded by the *than*-phrase (as in Hypothesis A), but lower-bounded by it as well. So we assume:

> **Hypothesis A** (Scope-Fixing Version)
> The scope of comparison is exactly the semantics of the sister of the *than*-phrase.

This ought to give the NPs in (26) semantics roughly like the following:

(27)a.   An m strong man such that [$m > s$ and John is an s strong man]
   b.   ?An m strong man such that [$m > s$ and Mary is an s strong man]
   c.   A man m strong such that [$m > s$ and John is s strong]
   d.   A man m strong such that [$m > s$ and Mary is s strong]

In particular the oddity of (b) is accounted for by the fact that *than Mary* must attach to the N̄ *stronger man* (assuming *than*-phrases must attach to constituents containing a comparative morpheme), which ends up predicating manhood of someone named Mary.

However, the Scope-Fixing version of Hypothesis A appears too strong. Consider:

(28)   A better man was killed today than any of us.

The scope-fixing version of Hypothesis A would predict that the only available reading for this sentence entails that all of us were killed today. One might still rescue the Fixed Scope Version of Hypothesis A by saying that it applied at a level of structure (say, for example, LF) at which *a better man than any of us* was a constituent.

However, the lower bounding of the scope-of-comparison seems shaky at best in the general case. Consider:

(29) a. Carol will decide to buy a more luxurious home today than her sister.
     b. Carol will decide to buy a more luxurious home today than her sister bought.

It appears possible for (a) to have a reading paralleling that of (b), that is, a reading on which Carol will make her decision today but not the purchase, and the decision will be to buy a more expensive home than her sister bought. But the *than*-phrase must attach high (above the temporal), and yet, on this reading, the scope of comparison must include only the buying predication.

In what follows, I will adopt only the weaker scope-bounding version of Hypothesis A. In Section 5.1, I try to show that with the right semantic machinery, the weaker version of Hypothesis A is all that is needed.

3.3. *Scope Variation and Quantifiers*

Consider sentences like the following:

(30) a. More men than women smoke.
     b. More men smoke than women smoke.

Here, (a) appears to be a counterexample to both versions of Hypothesis A in Section 3.2, since it is paraphrased by (b). The *than*-phrase has attached to an NP, but instead of taking NP-wide scope, the scope of comparison is sentence-wide.

The analysis I want to propose for these cases follows Keenan and Moss (1984). Attached to the NP *more men*, the *than*-phrase yields a quantifier. This creates an interesting asymmetry in the analysis, I will claim that sentences (a) and (b) are of very different natures

(31) a. A more expensive book was bought than *War and Peace*.
     b. More books were bought than magazines.

In (a), *A more expensive book* is the focus and *War and Peace* is the contrast, and HOU can be invoked to find the possible interpretations. In (b) there is no focus; HOU is not invoked for interpretation. Rather *more books . . . than magazines* is a discontinuous quantifier.

There is thus a gap in the HOU analysis of quantity comparatives. There are no degree-focus quantity comparatives. I will show below that

this is not just a stipulation but a necessary property of the HOU machinery as we set it up.

However, analyzing the NPs in (31) as distinct from all the other comparative cases leaves us with a rather uncomfortable division empirically. It would be helpful to find some corroborating evidence. Fortunately such evidence is to be found in two places: (a) the scoping properties of NPs such as those in (30) and (b), in the focus facts for quantity superlatives.

Turning first to scoping facts. We saw when we first motivated the scope-bounding version of Hypothesis A that the scope of comparison is bounded by its attachment syntactic attachment site. However, it is well-known the scope of ordinary NP quantifiers is not bounded in any such way. Thus, if *more men than women* is a quantifier whose scope can vary like other quantifiers, then sentences like the following ought to be ambiguous:

(32)   Each election year, California voters are required to decide on more ballot issues than candidates by November.

Here the semantic restrictions on the *by*-phrase ought to force low attachment of the *than*-phrase. If *more ballot issues than candidates* is a quantifier, however, this should hardly keep it from outscoping the predicate *require*. In fact, (32) shows this wide-scope reading. On that reading, the number of ballot issues California voters were required to decide on by November exceeds the number of candidates they were required to decide on by November. This is in contrast to the analogous example in Section 3.2, in which the *than*-phrase had to be attached to a VP, repeated here, where only one scope of focus was possible.

(33)   California voters have been required to decide more ballot measures than Nevada voters by November.

The behavior of the *than*-phrase in (32) is similar to the behavior of *only* when it attached to an NP, as observed in Taglicht (1984):

(34)a.   They were advised to only learn Spanish.
     b.   They were only advised to learn Spanish.
     c.   They were advised to learn only Spanish.

Here (34c) has the readings of both the (a) and (b) sentences. Thus, *only* appears to be able to attach to NP and become quantifierlike, varying its scope like an NP. The *than*-phrase in (32) exhibits similar scope variation.

Another argument for treating quantity comparatives like *more men than women* as quantifiers is that, in contrast to other comparatives, the

quantifier over degrees does not appear to be able to scope independently of the comparative NP. Consider the following three sentences:

(35) a. John thinks Roger Maris hit more career home runs than Babe Ruth.
     b. John thinks Babe Ruth hit more triples than home runs.
     c. John thinks Babe Ruth hit more triples than he hit home runs.

Consider the following situation. John thinks Roger Maris hit 1000 home runs, but has no beliefs about Babe Ruth's home run production. In fact, Babe Ruth hit 714 home runs, and Maris hit considerably fewer. In such circumstances (a) can be uttered truthfully. Thus, (a) can mean *there is an n such that n is the number of home runs Babe Ruth hit and John thinks Roger Maris hit more than n career home runs*. As we will see when we turn to the semantics of comparatives in the next section, this is a case where the quantifier over degrees (what I will call the comparative quantifier) takes wide scope.

Now suppose John, still ignorant of Babe Ruth's home run total, thinks that the Babe hit 1000 triples. Sentence (c) can be used to truthfully describe this situation, sentence (b) cannot. In other words, (b) can't mean: *there is an n such that n is the number of home runs Babe Ruth hit and John thinks Babe Ruth hit more than n triples*. Sentence (b) can only describe the state of affairs where John has opinions about both the Babe's home run total and his triple total, and thinks the latter is greater.[7] Now this gap in the possible readings of (c) can be explained if we think of the semantics of *more triples than home runs* as a single quantifier which must function as a single semantic unit. We show how to integrate such an analysis with ours in Section 5.2.

To summarize the facts of (35), the contrast between (35b) and (35c) in their available readings is strong evidence that (b) is not an elliptical version of (c). The fact (35a) and (35c) exhibit a reading in which the comparative quantifier takes wide scope and the comparative NP quantifier takes narrow scope shows that in both cases the two quantifiers must be able to scope independently. The fact that such independent scoping is not possible for (35b) suggests that the right logical form provides only one quantifier to scope.

So much for scoping facts. For further motivation for the quantifier-like status of NPs like *more men than women*, we turn to some examples

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[7] There is perhaps also a *de re* reading: *there are more triples than home runs x such that John thinks the Babe hit x*. The existence of this reading does not affect the point under discussion. Thanks to Geoff Nunberg for offering this example.

involving superlatives. The idea here is that the semantics we propose below will posit only a minimal difference between comparatives and superlatives. So if there are no degree-focus quantity comparatives, there ought not to be any degree-focus quantity superlatives either.

Consider the following minimal contrast between a degree superlative and a quantity superlative:

(36) a.   Brown's campaign has been joined by the most volunteers.
    b.   Brown's campaign was joined by the largest group of volunteers.

Both sentences have readings that make either *Brown* or *Brown's campaign* the focus, that is, readings on which Brown's campaign is compared to others for the number of volunteers. I claim however that (b) has a reading which (a) lacks, the degree-focus reading. On this reading we are comparing groups and no other campaign joinings are entailed. If the contrast-set includes all the political action groups in the County and the largest is the Silicon Valley Women's League, then this reading simply asserts that Brown's campaign was joined by the Silicon Valley Women's League. On this reading, *the largest group of volunteers* can be a referential NP.

The analogous reading for (a) would be: of the possible groups of volunteers, Brown's campaign has been joined by the group with the largest cardinality. This is not a possible reading. Sentence (a) can be understood only as quantifying over different volunteers groups and different joinings. Another way of putting this is: the NP *the most volunteers* simply cannot refer to a group of volunteers picked out by its cardinality; the NP *the largest group of volunteers* can.

In Section 5.2, we will propose an explanation for this asymmetry in quantity comparatives and superlatives.

4. SEMANTICS OF COMPARATIVES

4.1. *Subdeletion and Comparative Ellipsis*

To illustrate the approach to the semantics of comparatives taken here, it will be useful to start with a noncomparative example:

(37)   This desk is six feet wide.

I will represent the semantics of degree adjectives as a relation between individuals and degrees:

(38)   wide (that-table, [foot 6])

The term [foot 6] denotes a measure in an ordered set of measures with the sort of structure discussed in Krifka (1987) and Nerbonne (1991). As indicated in Section 2, I refer to the subclass of measures that modify adjectives and adverbs as degrees, and those that measure cardinality or mass as quantities.[8] It is not crucial to the issues discussed in this paper that degree adjectives be relations between individuals and degrees, but it is crucial that the semantics of a simple measure assertion like (38) have in it terms that correspond to an individual being measured and a measure.

I will also assume that adjectival relations are downwardly monotonic on their measure arguments, so that if (38) is true then

(39)   wide (that-table, [foot 5])

is also true. So the truth-condition of (38) will only require that table to be at least 6 feet wide. One advantage of this downward monotonicity is that the semantics of *that table is wide* can just be:

(40)   wide (that-table, STANDARD)

where STANDARD is a pragmatically fixed standard. The truth-conditions of (40) will then require that table to be at least as wide as the standard. The same will go for *that table is narrow*:

(41)   narrow (that-table, STANDARD)

The adjective *narrow*, however, will be associated with a distinct ordering of the domain of lengths which in effect reverses the scale. On the *wide* scale three feet exceeds two feet; on the *narrow* two feet exceeds three. Thus, a narrow table will be one that has a length of smaller magnitude than the standard.

The kind of comparative that is easiest to understand semantically occurs relatively infrequently:

(42)   This desk is longer than that table is wide.

I assume that (43) provides a satisfactory logical representation of (42):

(43) $\exists m[\forall s[\text{wide}(\text{that-table}, s), >(m, s)],$
         $\text{long}(\text{this-desk}, m)]$

---

[8] I certainly don't mean to propose a formal division between degrees and quantities. There is, in fact, a fascinating overlap in adjectival and mass specifiers, exhibited by such pairs as *a lot more wine* and *a lot taller*, *a great deal more wine* and *a great deal taller*, and *considerably more wine* and *considerably taller*. Then there are pairs such as

(i)   600 watts more powerful
(ii)   600 watts of power

Glossing the semantics: there exists a degree m such that for every degree s that is in the width relation to that table m is greater than s. Moreover, m stands in the length relation to this desk. Throughout the paper I assume determiners (including $\exists$) syntactically require both a restriction formula and a scope formula. The format is:

$$\text{Op } x[\phi, \psi]$$

where ϕ is the restriction formula and ψ is the scope formula.

The treatment of the comparative construction is like that of Cresswell (1976), and others that followed, in that it posits an indefinite quantification over the degree introduced by the main clause. It is unlike Cresswell in that it posits a universal quantification over the degree introduced by the *than*-clause.

One reason for the universal quantification of s is the downward monotonicity of the adjective relation. We need to require this desk to have a length taller than all the widths of that table in order to be sure that the maximal width is included. There are other motivations for the universal quantification, however. One is that the *than*-phrase is a negative polarity context:

(44)   John is smarter than any bureaucrat.

Another is the behavior of comparatives in modal contexts:

(45)   John can run faster than Bill.

This sentence should come out true only if John can run faster than any speed Bill can run. To get this right, one would need universal quantification even if the adjective relations weren't downwardly monotonic.[9]

The central claim of this semantics is that the comparative construction introduces a quantifier on measures restricted by the material in the *than* phrase. I will refer to the second-order property

$$\lambda P \exists m[\forall s[\phi(s), >(m, s)], P(m)]$$

as the *Comparative Quantifier*; $P(m)$ is the Comparative Quantifier's scope. There are thus two critical kinds of scope involved in the semantics of comparative ellipsis, the scope of the comparative quantifier (which is also involved in the semantics of all comparatives) and the scope of comparison, discussed in Section 2. I will argue below that these two kinds of scope are independent.

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[9] Thanks to Bob Moore for pointing this example out. Stechow (1984) discusses similar cases.

I will assume that each measure set has an ordering relation on measures that I will notate simply as $>$, and that comparatives use $>$. I will call the measure constrained by the main clause the *standard* and the measure constrained by the *than*-clause the *reference*.

Before turning to cases involving ellipsis, it will be useful to look at nonelliptical examples involving a numerical comparison. As in the cases of the adjectival comparatives, we begin with a non-comparative example:

(46)   John gathered six oranges.

The semantics of (46) is

(47) $(|6|)x$ [orange(x), gather(j, x)]

I take this to be equivalent to:

(48) $\exists x$ [and [orange(x), count-of$(x, 6)$], gather(j, x)]

Here *orange* is a downwardly closed predicate that ranges over both singular and plural entities. The semantics glosses: there is a group with count six all of whose members are oranges that John gathered. This semantics does not rule out the possibility that more than six oranges may have been gathered. The fact that sentences like (47) have the force that exactly six oranges were gathered in most contexts is regarded as a quantity implicature.[10]

Now consider:

(49)   Carol saw more hawks than Betty saw eagles.

As in the cases of the adjectival comparatives, the semantics contributed by the clauses in the comparative sentence is a lot like what is contributed by an analogous non-comparative clause:

(50) $\exists m[\forall s[(|s|)x[\text{eagle}(x), \text{see}(b, x)]>(m, s)],$
          $(|m|)x[\text{hawk}(x), \text{see}(c, x)]]$

In this case, the $\forall$ determiner does real work. Since the semantics of counting is downwardly closed, s can be satisfied by any number smaller than the exact number of eagles Betty saw in

$(|s|)x[\text{eagle}(x), \text{see}(m, x)]$

The universal quantification over s guarantees that each of Betty's eagle

---

[10] The assumption here is of a semilattice structure on group entities like that of Link (1983). The approach to cardinality determiners shares some features with that of Nerbonne (1991).

tallies, most importantly the maximum, will be exceeded by some hawk tally belonging to Carol.

We now turn to cases involving ellipsis. We begin with a brief summary of the framework of DSP, using a verb-phrase ellipsis example:

(51)a. Bill washed his car and John did too.
    b. AND[wash(b, car(b)), P(j)]

Given the semantics in (b), the problem of interpreting (a) now reduces to the problem of solving for the underspecified property P. In DSP, resolving that property involves the following steps.

1. Locate source: source: wash(b, car(b)).
2. Establish parallel elements and locate *primary occurrences* in source,

$$\text{wash}(\underset{.}{\text{b}}, \text{car(b)})$$

Parallel elements are constituents in a tree. Primary occurrences are terms in the semantic form. A primary occurrence in the source is a term contributed by a parallel element. Thus, the two subjects are parallel in (51a), and the first occurrence of b above is primary because it is contributed by the subject NP in the source. The second is not because it is contributed by a pronoun that is not a parallel element.
3. Set up equation,

$$P(\text{b}) = \text{wash}(\underset{.}{\text{b}}, \text{car(b)})$$

4. Solve equation,

Strict: $P = \lambda x[\text{wash } (x, \text{car(b)})]$
Sloppy: $P = \lambda x[\text{wash } (x, \text{car}(x))]$
               $P = \lambda x[\text{wash } (\underset{.}{\text{b}}, \text{car}(x))]$
               $P = \lambda x[\text{wash } (\underset{.}{\text{b}}, \text{car(b)})]$

5. Discard UNACCEPTABLE SOLUTIONS, that is, solutions containing a primary occurrence. DSP reject certain solutions that violate parallelism in that they do not abstract over a primary occurrence. In this case, the single primary occurrence is the occurrence of b filling the first argument role of *wash*. Thus, the third and fourth solutions above are unacceptable. This leaves exactly the two readings (51a) has when *his* is anaphoric to John.[11]

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[11] In the Appendix, I show how the restriction against solutions not abstracting over the primary occurrence can be made to follow from the theory of focus.

We now turn to cases of comparative ellipsis:

(52)   Jean gave her sister a more expensive book than Carol.

I propose to give this sentence a single underspecified semantics which can be resolved in various ways, depending on which focus is chosen and whether a strict or sloppy reading is chosen. The underspecified semantics is:

(53) $\exists m[\forall s[R(c, s), >(m, s)],$
                $\exists y[\text{AND}[\text{book}(y), \text{expensive}(y, m)]],\text{give}(j, \text{sister}(j), y)]]$

The idea here is that what the *than*-phrase contributes is just a relation between an individual and a measure:

$R(c, s)$

On the approach to the semantics of comparatives we have adopted, the *than*-phrase always introduces a proposition that restricts the comparative quantifier, whether or not the sentence is elliptical.

Note that the comparative quantifier (binding m) outscopes the comparative NP (binding y). Note also that knowing the full restrictor of the comparative quantifier entails knowing what's in the *than*-phrase which, in any surface representation of the syntax of (52), is much higher up the tree than the comparative adjective. We will account for this disparity between surface syntax and scope by means of a *comparative store mechanism*. What the comparative store contains will not be a generalized quantifier meaning but something which, combined with the *than*-phrase, gives a generalized quantifier. We will go into the compositional semantics in more detail in Section 5.1. Here it may simply help to note that the interpretation for the comparative adjective in (52) will be:

(54)   main semantics: $\lambda y \text{ expensive}(y, m)$
        comparative store: $\langle m, \lambda Q \lambda P \exists m[\forall s[Q(s), >(m, s)], P(m)]]\rangle$

When the *than*-phrase is encountered higher up the tree it contributes a property of degrees, in this case:

$\lambda d[R(c, d)]$

where 'c' is the semantics for *Carol*. The determiner-meaning in comparative store is applied to this to give:

$\langle m, \lambda P \exists m[\forall s[R(c, s), >(m, s)], P(m)]]\rangle$

From that point on there is no longer any reason to distinguish comparative storage from ordinary quantifier storage.

Note that the semantics of the comparative adjective and the treatment of the comparative store and the *than-phrase* are independent of whether the *than*-phrase is elliptical. One of the appealing features of this approach is that we can give *Jean gave her sister a more expensive book* the same semantics whether it is discourse bound or paired with a *than*-phrase. The compositional semantics is constructed independently of the ellipsis resolution. In the case of subdeletion, such as in (42), there will be no R relation to resolve: the *than*-phrase directly contributes a property of degrees. In the case of a discourse-bound comparative, such as, simply:

(55)   Jean bought her sister a more expensive book.

the missing property of degrees is supplied, not by HOU resolution, but pragmatically.

In elliptical sentences like (52), the quantifier is restricted by a relation R between an individual and a measure. The problem of interpreting the elliptical sentences reduces to the problem of resolving the relation R.

In the framework of DSP, solving for R means setting up a second-order equation on the basis of parallelism between the elliptical semantics and some template semantics. The steps are as follows:

1. Determine the scope of comparison. We will use the term scope of comparison rather than source because, as illustrated in Section 3.2, there are ambiguities in comparative ellipsis that can be captured only if the amount of material omitted in the ellipsis is allowed to vary. For simplicity let us assume that the *than*-phrase is being attached at the sentence level in examples like (52). Once the contribution of the *than*-clause is taken account of, I assume the information available to the compositional semantics at this point is the following:

   (56) main semantics: $\exists y[\text{AND}[\text{book}(y), \text{expensive}(y, m)],$
                            $\text{give}(j, \text{sister}(j), y)]]]$
         comparative store: $\langle m, \lambda P \exists m[\forall s[R(c, s), >(m, s)], P(m)]]]\rangle$

   For the time being let us simply stipulate that the scope of comparison is to be the semantics of the main clause before the comparative quantifier is retrieved. According to the scope-bounding version of Hypothesis A, this is the maximum possible scope of comparison. In Section 5.2, we will show how a scheme allowing free choice of scopes of comparison, constrained by a scope-bounding version of Hypothesis A, gets the right results.

2. Establish parallel elements and locate primary occurrences in source. In comparative ellipsis, there are two parallelisms to worry about.

One will simply be established by locating parallel elements in a syntactic tree. This is the parallelism of the focus and contrast. The other parallelism is that between the standard measure and the reference measure. Not wishing to adopt an abstract syntactic analysis for these cases, I will simply assume that parallelism of degrees is given by the construction. Thus, the unique occurrence of the standard in (56) will be a primary occurrence. Let us first consider the case where *Jean* is focus.

Main Clause:	[Jean]$_F$ gave Jean's sister an *m* expensive book
	Focus Standard
Than Clause:	Carol *s*
	Contrast Reference

3. Set up and solve equations. The idea is simply that the scope of comparison predicates some relation of the focus and the standard. The same relation R is predicated of the contrast and the reference. To find R we need to abstract it out of the scope of comparison.[12]

(57)   [Jean]$_F$: $R(j, m) = \exists y[\text{AND}[\text{book}(y), \text{expensive}(y, \underline{m})],$
$$\text{give}(\underline{j}, \text{sister}(j), y)]$$

   Strict: $R = \lambda z, x[\exists y[\text{AND}[\text{book}(y), \text{expensive}(y, z)],$
$$\text{give}(x, \text{sister}(j), y)]]$$

   Sloppy: $R = \lambda z, x[\exists y[\text{AND}[\text{book}(y), \text{expensive}(y, z)],$
$$\text{give}(x, \text{sister}(x), y)]]$$

4. Discard unacceptable solutions. Again these are just the solutions that have primary occurrences in them. There are five unacceptable solutions in all, two which fail only in leaving behind the primary occurrence of the focus, two which fail in leaving both primary occurrences, and one which fails in leaving behind the primary occurrence of the standard. Here are two of them:

(58) $R = \lambda z, x \exists y[\text{AND}[\text{book}(y), \text{expensive}(y, z)],$
$$\text{give}(\underline{j}, \text{sister}(x), y)]]$$

(59) $R = \lambda w, z \exists y[\text{AND}[\text{book}(y), \text{ expensive}(y, z)],$
$$\text{give}(\underline{j}, \text{sister}(x), y)]]$$

The first of these would give the impossible reading: *Jean gave Jean's*

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[12] We assume the relational notation convention of Montague (1974), whereby

$$R(x, y) = R(y)(x).$$

so that the degree argument is the first argument of the lambda expression.

sister a more expensive book than Jean gave Carol's sister. The second is just vacuous abstraction on both argument positions and would give the contradictory reading that Jean gave her sister a more expensive book than Jean gave her sister. The reader may verify that the other three unacceptable solutions all give impossible readings.

Having solved for elided material there is still the matter of evaluating a particular value R in the original underspecified semantics given in (53) to get a reading. Using the strict solution gives:

(60) $\exists m[\forall s[\exists x[\text{AND}[\text{book}(x), \text{expensive}(x, s)]],$
                    $\text{give}(a, \text{sister}(j), x)],$
                 $>(m, s)],$
              $\exists y[\text{AND}[\text{book}(y), \text{expensive}(y, m)]],$
                 $\text{give}(j, \text{sister}(j), y)]]$

Note that because of the universal this semantics says there is a book that Jean gave Jean's sister that is more expensive than *any* book Carol gave Jean's sister. Thus, in case Carol gave Jean's sister two books, it won't suffice just to edge out one of them. This seems correct.

The other reading to deal with is the case where *her sister* is the focus. In this case the equation is:

(61)   [her sister]$_F$: $R(\text{sister}(j), m) = \exists y[\text{AND}[\text{book}(y),$
                                        $\text{expensive}(y, m)],$
                              $\text{give}(j, \overline{\text{sister}(j)}, y)]$
              $R = \lambda z, x[\exists y[\text{AND}[\text{book}(\overline{y}), \text{expensive}(y, z)],$
                    $\text{give}(j, x, y)]]$

In this case, there is only one acceptable solution because there is only one primary occurrence for each argument of the relation. There are three unacceptable solutions, one which leaves behind just the primary occurrence of the focus, one which leaves behind just the primary occurrence of the standard, and one with vacuous abstraction on both argument positions of R, which leaves behind both.

5. Issues of Constrained Interpretation

5.1. *The Basic Scheme of the Compositional Semantics*

The basic approach taken here is to give the comparative sentences an underspecified semantics containing a higher-order variable, R and to resolve R independently of the compositional semantics. In this section we take a closer look at the compositional semantics, by showing how the

translations look at selected nodes in a simple example. In the next section
we take a look at how the resolution process works. Figure 1 shows the
compositional semantics for the main clause

(62)   Jean bought a more expensive book.

In this version of the semantics, I have assumed a treatment of quantifier
scope variation which uses a version of a quantifier storage mechanism
(see Cooper, 1975), though little hangs on this choice. At the top of the
tree the main translation of the sentence still contains a free degree
variable and the comparative quantifier-to-be (it is not yet really a quant-
ifier) is still in comparative store. Since it is then the type of a determiner,
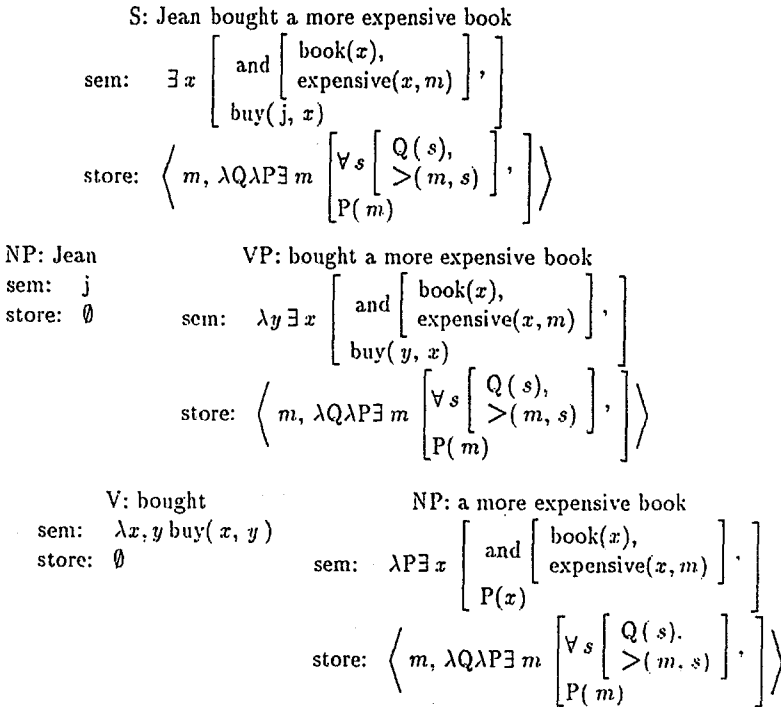let us call it the *comparative determiner*.[13]

$$S: \text{Jean bought a more expensive book}$$

sem: $\exists x \begin{bmatrix} \text{and} \begin{bmatrix} \text{book}(x), \\ \text{expensive}(x, m) \end{bmatrix}, \\ \text{buy}(j, x) \end{bmatrix}$

store: $\left\langle m, \lambda Q \lambda P \exists m \begin{bmatrix} \forall s \begin{bmatrix} Q(s), \\ >(m, s) \end{bmatrix}, \\ P(m) \end{bmatrix}, \right\rangle$

NP: Jean   VP: bought a more expensive book

sem: j
store: $\emptyset$ sem: $\lambda y \exists x \begin{bmatrix} \text{and} \begin{bmatrix} \text{book}(x), \\ \text{expensive}(x, m) \end{bmatrix}, \\ \text{buy}(y, x) \end{bmatrix}$

store: $\left\langle m, \lambda Q \lambda P \exists m \begin{bmatrix} \forall s \begin{bmatrix} Q(s), \\ >(m, s) \end{bmatrix}, \\ P(m) \end{bmatrix}, \right\rangle$

V: bought   NP: a more expensive book

sem: $\lambda x, y \, \text{buy}(x, y)$
store: $\emptyset$ sem: $\lambda P \exists x \begin{bmatrix} \text{and} \begin{bmatrix} \text{book}(x), \\ \text{expensive}(x, m) \end{bmatrix}, \\ P(x) \end{bmatrix}$

store: $\left\langle m, \lambda Q \lambda P \exists m \begin{bmatrix} \forall s \begin{bmatrix} Q(s), \\ >(m, s) \end{bmatrix}, \\ P(m) \end{bmatrix}, \right\rangle$

Fig. 1. Semantic Tree for *Jean bought a more expensive book*.

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[13] This is perhaps a little misleading since this comparative "determiner" isn't semantically
like other natural language determiners, despite having the same type. For example, it isn't
the case that:

Det(P, Q) = Det(P, Q ∧ P).

Thus, the Comparative Determiner isn't conservative.

The argument order of the comparative determiner is such that it doesn't make sense to quantify it into the main clause meaning until a missing property of degrees has been supplied. There are two ways this can happen. The missing property can be supplied by a *than*-clause, whose semantics must always be a property of degrees, or else it may be supplied by the discourse, often with some form of accommodation supplying the property of degrees, as when someone says:

(63)   Carol bought the complete works of Poe.

before (62). There is no price mentioned in (63), but it asserts a proposition in which Carol plays a role parallel to that of Jean. We thus assume it can be exploited to introduce the following property of degrees

(64) $\lambda d \, \mathrm{R}(\mathrm{c}, d)$,

where 'c' denotes Carol. The pragmatic relation can then be resolved in much the same way as we will resolve (52) in Section 4.1.[14]

Once a property of degrees is supplied pragmatically, the comparative determiner can be applied to it, and then quantified into the sentence, yielding the following *contextualized* semantics for the entire sentence:

$$\text{sem:} \quad \exists x \left[\begin{array}{l} \text{AND} \left[\begin{array}{l} \text{book}(x), \\ \text{expensive}(x, m) \end{array} \right], \\ \text{buy}(j, x) \end{array} \right]$$

$$\text{store:} \quad \left\langle m, \lambda Q \lambda P \exists m \left[\begin{array}{l} \forall s \left[\begin{array}{l} Q(s), \\ >(m, s) \end{array} \right], \\ P(m) \end{array} \right] (\lambda d \, \mathrm{R}(\mathrm{c}, d)) \right\rangle$$

$$\Rightarrow$$

---

[14] Note that the works of Poe can also be viewed as parallel to the book Jean buys. That is, (63) could be exploited to introduce the following property of degrees

$\lambda d \, \mathrm{R}(\text{works of Poe}, d)$

This pragmatic relation could then be resolved in much the same way as we resolve (66) in Section 5.2. This would be the only plausible parallelism if the previous sentence in the discourse did not assert any buying, e.g., *Carol praised the works of Poe.*

$$\text{sem:} \quad \exists x \begin{bmatrix} \text{AND} \begin{bmatrix} \text{book}(x), \\ \text{expensive}(x, m) \end{bmatrix}, \\ \text{buy}(j, x) \end{bmatrix}$$

$$\text{store:} \quad \left\langle m, \lambda P \exists m \begin{bmatrix} \forall s \begin{bmatrix} R(c, s), \\ >(m, s) \end{bmatrix}, \\ P(m) \end{bmatrix} \right\rangle$$

Storage retrieval for this quantifier is just like retrieval for any NP-quantifier. After retrieval we have:

(65)

$$\text{sem:} \quad \lambda P \exists m \begin{bmatrix} \forall s \begin{bmatrix} R(c, s), \\ >(m, s) \end{bmatrix}, \\ P(m) \end{bmatrix} \left(\lambda m \exists x \begin{bmatrix} \text{AND} \begin{bmatrix} \text{book}(x), \\ \text{expensive}(x, m) \end{bmatrix}, \\ \text{buy}(j, x) \end{bmatrix} \right)$$

store: ∅

$$\Rightarrow$$

sem: $\exists m [\forall s [R(c, s), >(m, s)],$
            $\exists y [\text{AND}[\text{book}(y), \text{expensive}(y, m)]], \text{buy}(j, y)]]$

store: ∅

The case of the *than*-phrase comes out identically, once we assume that all *than*-phrases denote properties of degrees, and that an elliptical *than*-phrase like *than Carol* denotes a property like (64).

5.2. *Varying the Scope of Comparison and Quantity Comparatives*

We indicated in previous discussion that the scope of comparison is under-determined by the site of the *than*-phrase in comparative ellipsis. In this section we look at what this means for the resolution machinery. We adopt a simple constraint on possible resolution equations that makes a number of correct predictions about the relation of scope of comparison to other operators that affect the parallel elements of the comparative construction.

We illustrate an important feature of how resolution must work with

the other example of a degree-focus comparative, as discussed in Section 2:

(66)   Jean gave her sister a more expensive book than *War and Peace*.

The unresolved semantics is:

(67) $\exists m[\exists y[\forall s[R(\text{War-and-Peace}, s), >(m, s)],$
        $\text{AND}[\text{book}(y), \text{expensive}(y, m)],$
        $\text{give}(j, \text{sister}(j), y)]]$

This example is quite different from those in the last section. In previous examples the scope of comparison was the semantics of the main clause, but in the reading desired here, there are no givings being compared. What is being compared is simply the price of two books.

For this reading the desired parallelism is:

Main Clause:	v	m
	Focus	Standard
Than-Clause:	War and Peace	s
	Contrast	Reference

where v stands for the variable bound by *a more expensive book*. The desired scope of comparison will predicate bookhood and some expensiveness of *War and Peace* will not include a giving predication. The constituent which contains just this information is the $\bar{N}$ *more expensive book*.

If we adopt the conventional Montagovian semantics for common nouns, we don't have anything corresponding to the variable v at the $\bar{N}$ level; but we don't really need to give R all its arguments in order to write a useful equation to help solve for it. Using Montague's relational notation convention, we assume:

$$R(\text{War-and-Peace}, s) = R(s)(\text{War-and-Peace})$$

Thus the target property predicated of *War and Peace* is

$$R(s)$$

On the reading we desire, this is what should be parallel to the $\bar{N}$ *more expensive book*.

Since s parallels m, the equations for this scope of comparison are

(68) $R(m) = \lambda y \; \text{AND}[\text{book}(y), \text{expensive}(y, \underline{m})]$

Here:

$$\lambda y \text{ AND}[\text{book}(y), \text{expensive}(y, m)]$$

is simply the semantics for the N̄ *more expensive book*. It is now clear why I have been calling this kind of comparative a degree-focus comparative. With this equation, the only parallel elements are the degrees.

There is only one solution abstracting over the single primary occurrence:

(69) $R = \lambda z, y[\text{AND}[\text{book}(y), \text{expensive}(y, z)]]$

Since R is applied to *War and Peace*, the sentence will be true only if *War and Peace* is a book. This, then, is one step in accounting for the entailment facts noted in Bresnan (1973) and illustrated in (26). For this account to be satisfactory, however, we still need to explain why (68) gives the correct scope of comparison for those examples.

This example illustrates a problem. We have seen that the scope of comparison can be as narrow as the Ā containing the comparative adjective. It can also be as wide as the sentence semantics. Given that it can vary, how do we determine the scope of comparison? What are the possible scopes of comparison? How does the scope of comparison interact with other scopes, for example, the scope of the comparative quantifier?

Thus far, we have proposed only one constraint on the scope of comparison, the scope-bounding version of Hypothesis A. I want to propose that scopes of comparison are also constrained by an interpretive principle requiring that resolutions of ellipsis equations be based on well-formed parallelisms.

The status of this requirement of well-formed parallelism is rather like that of the recoverability of deletion in a deletion-based account of ellipsis. It is a principle governing a rule in a special component of the grammar; it is certainly not a language-specific principle, but to call it a principle of universal grammar is inappropriate as well, at least if universal grammar principles are thought of as empirical discoveries about the structure of language. The requirement on parallelism of one theory and the principle of recoverability of deletion in the other are more like parts of the definition of what elliptical language is: Any rule that didn't build in something like a requirement on well-formed parallelism or recoverability of deletion, simply wouldn't be called an ellipsis rule.

To illustrate the idea of a well-formed parallelism, consider the semantics shown in (67). What would have happened if we had chosen a wider scope of focus, say the main semantics in (56)?

The equations and solutions would have been:

(70)   [Jean]$_F$: $R(y, m) = \exists y[\text{AND}[\text{book}(y),$
                                    $\text{expensive}(y, \underline{m})], \text{give}(j, \text{sister}(j), y)]$
        Solution: $R = \lambda z, x[\exists y[\text{AND}[\text{book}(y),$
                                    $\text{expensive}(y, z)], \text{give}(j, \text{sister}(j), y)]]$

Note that this solution for R has a vacuous abstraction, but it is not blocked as our previous vacuous abstractions were, because there is no offending primary occurrence on the right hand side. Not surprisingly, the reading predicted by (70) is incorrect:

(71) $\exists m[\forall s[\exists z[\text{AND}[\text{book}(z), \text{expensive}(z, s)]],$
            $\text{give}(j, \text{sister}(j), z)], >(m, s)],$
        $\exists y[\text{AND}[\text{book}(y), \text{expensive}(y, m)]],$
            $\text{give}(j, \text{sister}(j), y)]]$

That is, there is an *m* such that for all *s* such that Jean gave her sister an *s* expensive book, *m* is bigger than *s*: and Jean gave her sister an *m* expensive book. The worst thing about this reading is not that it is contradictory, but that it has nothing to do with *War and Peace*.

I want to block this kind of nonsensical result by saying that Equation (70) uses a non-parallel source, where a parallel source is defined as follows:

Parallel Source
A *parallel source* is one which yields an equation which has solutions that do not vacuously abstract over any argument position.

The Parallel Source Constraint (PSC)
No valid ellipsis equation uses a non-parallel source.

A non-parallel source is simply any source all of whose solutions require a vacuous abstraction. Equation (70) proposes a non-parallel source. The intuition here is quite simple. If R is the relation being solved for then its arity is simply the number of contrasts, the number of elements for which we must find parallels in the source. An equation with no nonvacuous solutions is simply one for which no true parallelisms have been found.[15] Clearly, (70) uses a non-parallel source.

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[15] Careful readers of DSP will note that they posit no restriction against vacuous solutions. But the proposal here is not a restriction on solutions but on equations, specifically ruling equations all of whose solutions require a vacuous abstraction. Nevertheless, DSP discusses a potential problem for the proposal here, the treatment of dummies in example like:

I will show that if we restrict ourselves to parallel sources the maximal scope of comparison in a degree-focus comparative is the N̄. Consider (67). There are four cases to look at:

(72) 1. N̄ scope: okay.
     2. The scope of comparison is the scope of the indefinite.

$$R(y, m) = \text{give}(j, \text{sister}(j), y),$$

   Here there is no primary occurrence of m on the right-hand side of the equation. Therefore, there is no hope of a solution without some vacuous abstraction, and this source is non-parallel.
     3. The scope of comparison is the sentence with the indefinite quantified in and R is a first-order relation. This is the case we saw in (70). The problem with (70) is that there is no primary occurrence of y on the right-hand side. Thus the source is non-parallel.
     4. The scope of comparison is the sentence with the indefinite quantified in. R is a higher-order relation. The system in DSP allows type-lifting in order to deal with cases where one or both of the parallel elements is a quantifier. Thus, in analyzing:

   Every student revised his paper, and John did too.

   John can be made parallel to *Every student* by type-lifting. On this account (66), *War and Peace* is parallel not to an individual-level variable, but to the indefinite quantifier, *a more expensive book*. It is thus type-lifted to be a quantifier:

$$\lambda P[P(\text{War-and-Peace})]$$

   and the verb-phrase property is correspondingly type-lifted to allow such arguments. The analogue in comparative ellipsis will

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Johna said it would rain and it did.

They assume that the equation induced by such an example might be:

$$P(\Delta) = \text{rain}$$

Here *rain* is of propositional type. And Δ denotes what L. Karttunen calls an 'ugly object'. But F. Pereira (pc) points out that as long as Δ is a real term in the logic, it might just as well be:

$$P(\Delta) = \text{rain}(\Delta)$$

with *rain* of property-type.

be to type-lift R in one argument position to allow that argument to be a quantifier. The resulting equation is

$$R \left(\begin{array}{l} \lambda P[\exists y[\text{AND}[\text{book}(y), \\ \qquad\qquad \text{expensive}(y, m)], m \\ \qquad P(y)]] \end{array} \right)$$
$$= \exists y \left[\begin{array}{l} \text{AND}[\text{book}(y), \\ \qquad \text{expensive}(y, m)], \\ \text{give}(j, \text{sister}(j), y) \end{array} \right]$$

But this, too, has no solutions that do not involve vacuous abstraction. In this case no solution can simultaneously abstract over the focus quantifier and m the standard. Two of the solutions are

$$R = \lambda \mathscr{P}, z[\mathscr{P}(\lambda y[\text{give}(j, \text{sister}(j), y)])]$$
$$R = \lambda \mathscr{P}, z[\exists y[\text{AND}[\text{book}(y), \\ \qquad\qquad \text{expensive}(y, z)], \\ \qquad \text{give}(j, \text{sister}(j), y)]]$$

There is also a solution that vacuously abstracts over both argument positions.

The result of this enumeration of the possibilities is that if we eliminate all the equations that have only vacuous solutions, then $\bar{\text{N}}$ scope is the maximal one remaining.[16]

Note that the Parallel Source Requirement (PSR) makes no appeal to the syntactic placement of the *than*-phrase. In general the prediction is that extraposing the *than*-phrase in a degree-focus comparative should have no effect on the scope-of-comparison in degree-focus comparatives, and this seems correct:

(73) a.   A more competent engineer than Bonnie was hired.
     b.   A more competent engineer was hired than Bonnie.

It would be a problem for the PSR if (b) had a reading which entailed that Bonnie was hired. To get this reading we would need a source which included the hiring predication. But any such source, by an argument paralleling the one we made for (66), would have to be non-parallel.

We are now in a position to formulate a principle for choosing scopes

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[16] There is one other scope-of-comparison which is *smaller*, the $\bar{\text{A}}$ *more expensive*. We discuss this possibility below.

of comparison when setting up equations to resolve R. The following constraint follows from the scope-bounding version of Hypothesis A and the PSC:

> **The Scope of Comparison Constraint** (SCC)
> The scope of comparison may be any constituent C-commanded by the *than*-phrase such that its translation provides a parallel source.

Note that the SCC does not quite provide an account of the adjectival entailment facts noted in Bresnan (1973) and illustrated in sentence (26):

(74)   ?A stronger man than Mary was found.

The widest scope of focus that yields an acceptable equation is the N̄. But nothing in the Scope of Comparison Principle (SCC) rules out choosing a narrower scope of focus, the Ā *stronger*. This yields a felicitous reading that does not predicate malehood of Mary. Moreover trying to fix it by requiring the scope of comparison to be the *maximum* bounded parallel source won't work either, as we saw in examples like (29).

I leave this as a problem for future research, but I note in passing that this constraint seems syntactic rather than semantic in nature. Note that with discourse-bound comparatives, it does not appear to hold:

(75)   Mary was not up to the task. A stronger man was found.

The chief effect of the SCC is to prevent vacuous parallelisms and to constrain the scope of comparison when only the degree is in focus. An unexpected consequence of this second function is that for quantity comparatives and superlatives, degree-focus is impossible.

We argued above that when the comparative NP is the focus, the only possible scope of focus is N̄. The same arguments that ruled out other choices of scope apply to quantity comparatives and superlatives. The only difference is that the possibility of an N̄ scope has also been removed, because with the quantity variable m in the determiner, there is no occurrence of m in the N̄ semantics:

Claim: Degree focus is not possible in quantity superlatives or comparatives. The following possible scopes of comparison are all ruled out:

1. N̄: No occurrence of the degree variable m.
2. Recapping the argument in (72)[2–4]: The sentence semantics with the indefinite *a more expensive book* quantified in is not a parallel source because it has no free ocurrences of the comparative NP

variable y. But any narrower scope lacks the degree variable m. Changing R to a higher-order relation does not affect the argument.

Given the structure of our semantics, it is difficult even to consider a concrete example with comparatives, because it is not clear what to make an argument of R. Consider:

(76)   Carol saw more hawks than eagles.

If this were comparative ellipsis, the underspecified semantics might be:

(77) $\exists m[\forall s[R(\lambda P(|s|)[eagle(z), P(z)], s), >(m, s)],$
          $(|m|)x[hawk(x), see(c, x)]]$

This underspecified semantics assumes R takes a second-order property as its focus argument. It would lead to the following equation:

$$R(\lambda P(|s|)[hawk(z), P(z)], m) = (|m|)x[hawk(x), see(c, x)]$$

This has no nonvacuous solutions, because s occurs free on the left side but not on the right side. As noted above, an $\bar{N}$ scope of comparison is too narrow because it leaves out the crucial m. In sum, there is no way to make semantic sense of this. When we turn to quantify superlatives, we will see exactly the same problem arising: there will be no way of making the superlative NP the focus.

Having said what NPs like the one (76) are not, it might be helpful to say what they are. We argued in Section (3.3) that quantity comparatives which appeared to be degree-focus comparatives were actually quantifiers, pointing to their special scoping properties as evidence. In terms of the operators we have been using throughout, this analysis of *more hawks than eagles* can be expressed:

(78) $\lambda P\exists m[\forall s[(|s|)y[eagle(x), P(y)],$
              $>(m, s)],$
          $(|m|)x[hawk(x), P(x)]]$

This just describes the facts we have been pointing to. In ways there is no ellipsis resolution involved in these cases. The scope of the quantifier just determines what we have been calling the scope of comparison. Thus the limited scoping possibility of a sentence like (35b), repeated here, follows at once:

(79)   John thinks Babe Ruth hit more triples than home runs.

It is worth noting in passing that this "quantifier" construction has its own elliptical subconstructions:

(80)a. More pictures of castles than lakes were sold.
     b. More pictures of castles than pictures of lakes were sold.

I assume (a) is just elliptical for (b). Presumably something like the HOU machinery could be invoked to resolve this ellipsis, but we pass over the details here.

In Section 6, we will show how the SCC makes further correct predictions about the focus possibilities for quantity superlatives.

5.3. *The Scope of the Comparative Quantifier*

We have identified three distinct parameters of variation that affect the semantics of comparatives: the scope of the comparative quantifier, the scope of comparison, and the syntactic site of the *than*-phrase. In this section we briefly discuss the interaction of these three parameters.

In the previous sections we saw examples where the *than*-phrase was located higher in the tree than the scope of comparison. Adopting the scope-bounding version of Hypothesis A, we showed how free choice of any C-commanded nodes could yield the right equations for resolving R. Thus we have already seen cases where the scope of comparison was less than the "scope" of the *than*-phrase.

We now show that the comparative quantifier can scope wider than both the scope of comparison and the site of the *than*-phrase. In Section 3.3 we considered an example closely related to the following:

(81)   John thinks Roger Maris hit more home runs than Babe Ruth
        in his career.

The relevant reading was true in the following situation. John thinks Roger Maris hit 1000 career home runs, but has no beliefs about Babe Ruth's career home run production. In fact, Babe Ruth hit 714 home runs, and Maris hit considerably fewer. This reading can be represented:

(82) $\exists m[\forall s[(|s|)h[\text{home-run}(h),$
                         $\text{hit-in-career}(\text{babe}, h)], >(m, s)],$
                $\text{believe}(\text{john}, (|m|)k[\text{home-run}(k),$
                                      $\text{hit-in-career}(\text{rog}, k)]]$

To derive this reading, the scope of the comparative quantifier must be the S-node dominating *John believes Roger Maris hit more home runs than Babe Ruth in his career*. Thus, the comparative quantifier's scope outscopes the *than*-phrase. This is support for calling it a quantifier.

What this means for the compositional machinery is simply that a com-

parative quantifier can go into ordinary quantifier-store after it has been retrieved from comparative store, that is, after it has been matched up with its *than*-phrase. It can then be given whatever scoping is consistent with the principles of one's theory of NP-scoping.

6. MAXIMAL MEASURE CONSTRUCTIONS

6.1. *Maximal Degree Constructions*

We begin by proposing an underspecified semantics for (8), reproduced here:

(83)   Jean gave her sister the most expensive book.

The underspecified semantics is

(84) $\exists m[\forall s[\exists x[C(x), R(x, s)], \geqslant (m, s)],$
            the $y[\text{AND}[\text{book}(y), \text{expensive}(y, m)]]$
            give(j, sister(j), y)]

There are several differences here from the semantics of a comparative ellipsis sentence. First, the position filled by the contrast in the *than*-phrase has been existentially quantified over, with that quantification restricted to the members of a contrast-set C. Under the scope of $\forall$, this has the effect of a universal quantification. Second, the ordering relation has been changed from $>$ to $\geqslant$. This is because the focus is in the contrast-set too, and if the sentence is ever to be uttered truthfully, ties with the highest scoring element of the contrast-set must be allowed.

The equations for (84) when *Jean* is focus and for the case when *her sister* is focus are exactly as they were for the comparative analogue discussed in Section 4.1, as are the solutions. As was noted in Section 2, sentence (83) has another reading, parallel not to (52) but to (66). This is what we called the degree-focus reading. The equation for this reading is exactly the same as the equation for (66), given in (68).

One might argue for the inclusion of the contrast-set C in (84) on the basis of a general requirement that all quantification should be contextually restricted. But there is an independent motivation for making it explicit in the semantics of superlatives. Sometimes the contrast-set can be associated with syntactically overt material:

(85)a.   Of the three sisters, Jean bought the most expensive book.
    b.   Which sister bought the most expensive book?

c. Which sister bought the most expensive book, Carol, Jean, or Betty?

Thus, (85a) is appropriate only when *Jean* is the focus, and the set of buyers Jean will be compared to is the set of the three sisters in question, which must include Jean. In (85b), on what is probably the most accessible reading, the contrast-set is identified with the restriction-set of the *wh*-phrase, but does not have to be; in (85c), however, the contrast-set is fixed by the disjunctive tag, which functions much like an *of*-phrase to define the set of possible alternatives.

Whether the contrast-set is overt or not, reference to the contrast-set will be essential in arriving at the correct treatment of maximal-degree constructions with comparative adjectives. The only difference between the semantics of *Jean gave her sister the more expensive book* and the semantics in (84) is that the contrast-set may be required to have cardinality two. This requirement, while perhaps defeasible, helps in correctly describing the semantics of one of the more puzzling uses of comparative adjectives, discussed in Section 3.1, their maximal-measure readings in sentences like

(86)   Is John or Bill taller?

Here the correct result is obtained simply by giving the disjunction wide scope. Abstracting away from the semantics of yes/no questions, the fully specified content of (86), after R has been determined, is:

$$\text{OR}[\exists m[\forall s[\exists x[C(x), \text{Card}(C, 2), \text{tall}(x, s)], \geq (m, s)],$$
$$\text{tall}(j, m)],$$
$$\exists m[\forall s[(\exists x[C(x), \text{Card}(C, 2), \text{tall}(x, s)], \geq (m, s)],$$
$$\text{tall}(b, m)]]$$

Crucially, the semantics of both disjuncts is the same, except for substituting John for Bill. Thus the same contrast-set is used in both instances. We are asking if it is the case that John is the tallest member of that contrast-set or that Bill is the tallest member. The contrast-set has, as usual, been left to be fixed pragmatically. But if we also require the contrast-set to contain the focus, and keep the same contrast set in both disjuncts, then we are looking for a set with cardinality two that contains both John and Bill. There is only one such set. Note that simply removing the cardinality requirement and adding a third disjunct will give us the correct semantics for:

(87)   Is John, Mary, or Bill the tallest?

Nothing in the semantics would prevent a contrast-set with arbitrarily many members, and that seems to accord with our linguistic intuitions.[17]

Finally, it is worth noting an interesting difference between comparatives and superlatives with regard to the scope of the comparative quantifier.

(88)a.   John believes Roger Maris hit more home runs than Babe Ruth.

   b.   John believes Roger Maris hit the most home runs.

As we noted in Section 5.3, the scope of the comparative quantifier is independent of the scope of comparison in comparatives. In particular, sentence (a) has a reading which is *de re* on the quantity of home runs John believes Roger Maris hit. Without John believing anything about Babe Ruth's home run total, (a) can be true. But (b) lacks the analogous reading. That is, (b) lacks the reading which would be true if John believed Roger Maris hit 900 home runs, has no beliefs about any other baseball players, and 900 home runs happens to be more than anyone else hit. We can sum this up by saying that with superlatives, it appears that the scope of comparison and the scope of the comparative quantifier must coincide.

This means that setting up the resolution equations for superlatives is more constrained and simpler than it is for comparatives. In effect, the scope of comparison is determined once the scope of the comparative quantifier is determined, and only one scope of comparison needs to be considered.

6.2. *Special Properties of Maximal Quantity Construction*

We saw in Section 3.3 that the superlative NP could never be the focus in quantity superlatives, using an example repeated here:

(89)   Brown's campaign has been joined by the most volunteers.

This sentence has readings that make either *Brown* or *Brown's campaign* the focus, but no degree-focus reading.

The underspecified semantics is:

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[17] A syntactic point to note in passing: I am inclined to analyze *the tallest* in *Is John, Bill, or Mary the tallest?* as a predicative adjective rather than a headless NP, despite the definite article. This is because of the occurrence of the definite article in adverbial superlatives, where the headless NP analysis is hard to motivate:

Which candidate executed his task the most efficiently?

(90) $\exists m[\forall s[\exists x[C(x), R(x, s)], \geqslant(m, s)], (|m|)y[\text{volunteer}(y),$
        $\text{join}(y, \text{ brown's campaign})]]$

The equation when *Brown's campaign* are focus are:

$R(\text{Brown's campaign}, m) = (|m|)y[\text{volunteer}(y),$
$\qquad\qquad\qquad\qquad\qquad \text{join}(y, \text{ brown's campaign})]]$
$R = \lambda z, \lambda x(|z|)y[\text{volunteer}(y), \text{join}(y, x)]]$

This will give the reading on which Brown's campaign was joined by more volunteers than any other entity in the contrast set.

In Section 3.3 we evoked the missing reading of (89) by comparing it to an adjectival superlative:

(91)   Brown's campaign was joined by the largest group of volunteers.

When *the largest group of volunteers* is focus, we have the reading comparing groups, which simply asserts that Brown's campaign was joined by the largest group in the contrast set.

There is no analogous reading for (89). Sentence (89) can be understood only as quantifying over different volunteer groups and different joinings. Another way of putting this is: the NP *the most volunteers* simply cannot refer to a group of volunteers picked out by its cardinality; the NP *the largest group of volunteers* can.

The reason that (89) lacks the degree-focus reading is that there is no parallel source available with that choice of focus. The argument was given in Section 5.2. Crucial to this account is the fact that in quantity NPs of the form *the most Xs,* the cardinality part of the semantics is part of the determiner. Thus any scope of comparison that includes that determiner fails to contain any free occurrences of the NP variable.

There is a trick operating here, but it is a trick which has a useful shape. Recall that

(92) $(|6|)x[\text{orange}(x), \text{gather}(j, x)]$

was defined to be equivalent to:

(93) $\exists x[\text{and } [\text{orange}(x), \text{count-of}(x, 6)], \text{gather}(j, x)]$

In this other representation the variable m is available inside the scope of the binder of x. In this representation, $\bar{N}$ would be a possible scope of comparison. This representation, in fact, makes quantity comparison identical to degree comparison. There would no different predicted for the focus possibilities of *the most competent engineer* and *the most engineers.*

That this difference of representation makes a difference suggests that there is something right about calling *six* a determiner in *six oranges*. The very existence of quantity comparative constructions shows that the quantity position in a quantity quantification can be quantified into (as does the existence of *how many* questions), but this leaves open the question of whether it is a determiner. Representation (92) says that the quantity term bears a special relation to the NP variable it is "counting", a relation quite distinct from the relation degree variables bear to the comparative NP variable. Representation (93) says there is no difference. We have now seen some strong evidence favoring (92).

This has certain consequences for syntactic constructions that are dependent on the focus NP:

(94) a.   The most expensive ring of the set had a tourmaline setting.
     b.   *The most rings of the set were tourmaline.
     c.   Of the set, the most expensive ring had a tourmaline setting.
     d.   *Of the set, the most rings were tourmaline.

As noted in Section 6.1, *of*-phrases can be used to make the contrast-set of a superlative explicit. But the sentence in which the *of*-phrase is associated with the superlative quantity NP are unacceptable. This would force the degree-focus reading and this reading is impossible for quantity superlatives.

Another consequence, is that, in quantity superlatives, the superlative NPs cannot be the only NP in the sentence, because that, too, forces the degree-focus reading. If the superlative NP is not available to be focus, and nothing else can be focus, then the semantics is incoherent:[18]

(95)   ?The most T-shirts were medium.

Intuitively, if there is no focus, then there is no entity that is maximal in

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[18] The larger grammatical question is: Why is the semantics incoherent in this case? The argument in the body of the paper shows that no equation can be set up in these cases, but all that is in the semantics per se is a pragmatic variable. Presumably not all pragmatic variables have to be resolved by equations related to constituents in a syntactic tree. What makes these pragmatic variables such that they are resolvable only through equational means? One answer is to be found in the Appendix, where the theory of focus is invoked to set up logical forms that effectively enforce the equational constraints.

the contrast-set with respect to some property.[19] There will be no way to set up equations to solve for R.

7. CONCLUSION

In this paper I have argued for an analysis of comparatives that provides a uniform semantics for comparative ellipsis, superlatives, and discourse-bound comparatives. The approach advocated uses Higher Order Unification to resolve the elliptical comparative construction, and together with some natural assumptions about the compositional semantics and the syntax of *than*-phrases, makes some interesting predictions about scope and the focus differences between quantity and degree comparatives and superlatives.

8. APPENDIX: FOCUS

In this Appendix I try to show how the kinds of equations used in the HOU account can be derived from a theory of parallelism taken together with the account of focus in Rooth (1992), in particular, from his analysis of comparative ellipsis as invoking contrastive focus. In the course I will explain away the notion of *primary occurrence* in DSP in terms of the theory of focus. I begin by sketching the essentials of his analysis of a *contrastive* focus, since this is what is directly relevant here.

In Rooth's semantic system, each constituent is assigned two semantic values, a denotation and a focus semantic value. For any constituent α, if the denotation is an object of type T, the focus semantic value is a set of objects of type T. Thus for sentences, which is what will concern us here, the denotation is a proposition and the focus semantic value is a set of propositions. The particular focus semantic value is determined by where the focus feature falls in a sentence. For a sentence like *Jean likes Carol*, we have two possible choices of NP focus and two corresponding focus semantic values, we can informally notate as:

$$[[\text{[Jean]}_F \text{ likes Carol}]]^0 = \{x \text{ likes Carol} \mid x \in E\}$$
$$[[\text{Jean likes [Carol]}_F]]^0 = \{\text{Jean likes } x \mid x \in E\}$$

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[19] There may be a marginal reading on which the focus is the *property* of being medium. The relevant context would be:

(i)   A certain number of the T-shirts left were large, and a number were small, but the most T-shirts were medium.

The existence of this reading does not really affect the point under discussion. It is still the existence of an external focus that rescues the sentence.

Here E is the set of entities in the domain. The focus semantic value when *Jean* is focus, for instance, is the set of propositions of the form x likes Carol, where x is an element of the domain.

In Rooth's system the role of the focus semantic value of a constituent is limited exclusively to stating the presuppositions of the focus operator, written $\sim$. In the case where the scope of the focus operator is a sentence, the configuration for the operator looks like this:

```
        S
       / \
      /   \
    S₈    ~p₇
```
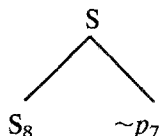
In this configuration, in the case of contrastive focus, the presupposition enforced by the $\sim$ operator is that

(96) $[\![p_7]\!] \in [\![S_8]\!]^0$.

That is, when a sentence is contrastive, there must be some proposition in the discourse which is an element of its focus meaning.

That a theory of parallelism is required for the complete analysis of ellipsis seems inevitable for any theory that dispenses with deletion. Something must account for the fact that (97a) cannot be paraphrased as (97b):

(97) a.   Bill likes Mary and Tom, Sue.
     b.   Bill likes Mary and Sue likes Tom.

Such a theory must also take into account facts of syntactic matching. Thus (98a) is ambiguous, but (98b) is not:

(98) a.   Bill is fonder of Mary than Sue.
     b.   Bill is fonder of Mary than of Sue.

I do not give the theory of parallelism here but I assume that it will give us two things, first a constraint against any solution to an ellipsis equation that involves vacuous abstraction. This is a strenghthening of the Parallel Source Constraint of Section 5.2, which only precluded equations all of whose solutions required vacuous abstraction.

Strengthened Parallel Source Constraint (SPSC)
No valid solution to an ellipsis equation uses vacuous abstraction.

I propose this stronger version here, because it seems like a more natural

starting point for a theory of parallelism, and because it allows for an account which dispenses with the notion of primary occurrence.

The second element the Theory of Parallelism must provide is a pairing of elements from the source clause with elements from the target clause. We will require of any ellided relation R that paired elements in the source and target fill the same role.

I also assume that the theory of parallelism links up with the theory of focus: Parallel elements are always foci. All that the pairing of the elements tells us is *which* element in the source goes with which element in the target. Thus, the theory of focus will mark *Bill, Mary, Sue* and *Tom* as foci in (97a), but the theory of parallelism will be responsible for excluding the pairing of *Bill* with *Tom*, and thus excluding interpretation (97b). In the comparative construction in (101), I assume m is paired with s and j is paired with c.

We will proceed by deriving the analysis of sentence (6), reproduced here:

(99)   Jean gave her sister a more expensive book than Carol.

We will concern ourselves with the reading on which *Jean* is focus. I will abstract away from the details of the logical forms chosen in this paper, and represent the ellipsis equation posited by the HOU framework as:

(100) $R(j, m) = j$ gave sister(j) an m expensive book

The key point is that whatever the exact logical form of *Jean gave her sister a more expensive book*, the translations of *Jean* and *her sister* and the degree term are the only free terms available to the HOU solver.

Although Rooth (1992) discusses cases of comparative ellipsis that involve contrastive focus, he assumes an analysis of comparatives with only one degree binder instead of two, so that the logical forms he proposes are incompatible with those used here.[20] I will propose an alternative schematic logical form stripped to the essentials required here.

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[20] Rooth (1992) uses contrastive focus in discussing imperatives, but not *mutual* contrastive focus. He discusses but does not endorse the mutually contrasting foci of the main clause and *than*-clause adopted here. He notes that the mutually contrasting analysis accounts for the intonational prominance of the remnants.

(101)

$$S$$

$$S \qquad XP$$

$$S_8 \qquad \sim p_7 \qquad than \qquad S$$

[j]$_F$ gave sister(j) an
[m]$_F$ expensive book

$$S_7 \qquad \sim p_8$$

$$R([c]_F, [s]_F)$$
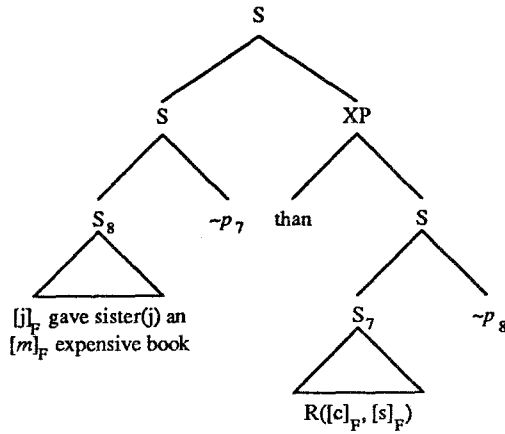
The key point to note here is that parallel elements are all picked out as foci. This requires that both degree variables bear the focus feature. Indeed, to derive any of the equations of this paper from a Rooth-style contrastive analysis would require that the degree variables count as foci. I assume this is possible, since they are associated with quantifiers, and I assume the lack of any intonational correlate is due to the fact that those quantifiers are unpronounced.

Some construction-specific stipulation is required for (101), but I leave open the question of how much of (101) can be derived from general assumptions in the theory of focus and how much is construction-specific. For example, to get the right semantics a mutually contrastive cross-indexing of the main clause and than clause is required, with p_7 indexed to S_7, and p_8 indexed to S_8. Presumably this cross-indexing account could be extended to other cases of ellipsis. What appears to be special about elliptical *than*-clauses is that this particular cross-indexing configuration is obligatory. That is, elliptical *than*-clauses must get their interpretation from the accompanying main clause, not from any other pragmatically available relation on degrees. Consider

(102)   Jean bought a cheap diamond ring. Alice bought a more expensive car than Carol.

Thus, the second sentence in this discourse cannot mean

(103)   Alice bought a more expensive car than Carol bought a diamond ring.

even though there is a perfectly good relation between individuals and the price of the diamond rings they buy available in context.

The tree in (101) has two focus operators, and two focus operators means two distinct presuppositional constraints to satisfy. Given the requirement on the focus operator in (96) and the fact that p_7 is equal to $R(c, s)$ and p_8 is equal to j gave sister(j) an m expensive book, we have:

(104) 1. $R(c, s) \in \{x$ gave sister(x) an m expensive book $| x, m \in E\}$ or
           $R(c, s) \in \{x$ gave sister(j) an m expensive book $| x, m \in E\}$
      2. j gave sister(j) an m expensive book $\in \{R(y, d) | y, d \in E\}$

Constraint (1) represents the presuppositional constraint associated with the main clause. From (1) we can conclude:

(105)   **Main-Clause Constraint:**
        $\exists x, m \in E[R(c, s) = x$ gave sister(x) an m expensive book or
                        $R(c, s) = x$ gave sister(j) an m expensive book]

The theory of focus must somehow account for strict/sloppy ambiguities in focus constructions by giving two possible focus semantic values for clauses with appropriately located pronouns. I do not know exactly how Rooth's system produces these semantic values in these cases, but for expository reasons I have expressed the result as a disjunction. It makes little difference to the point here whether strict sloppy ambiguities are represented in distinct analyses or as disjunctive focus semantic values.

Constant (2) in (104) represents the presuppositional constraint associated with the *than*-clause. From this we can conclude:

(106)   **Than-Clause Constraint:**
        $\exists y, d \in E[j$ gave sister(j) an m expensive book $= R(y, d)]$

I will now argue that (105) and (106), taken together with the theory of parallelism, derive (100); I then show that the solutions of R that respect the theory of parallelism and the presuppositions enforced by the theory of focus are precisely those in which a primary occurrence is left behind.

Constraint (106) is a constraint imposed on values for R by the presuppositions of the *than*-clause as given by the Theory of Focus. The proof proceeds by eliminating all but one instantiation of the existentially quantified variables in (106), that is, by showing there is only one permitted solution for Y and D in the following equation:

(107)   j gave sister(j) an m expensive book $= R(Y, D)$

Y and D have an infinite number of solutions, of course, but all but ten

of them will lead to an equation that fail not only the test by the SPSC, but also the test imposed by the weaker PSC; that is, they lead to an equation in which all solutions for R will require vacuous abstraction.[21] Here is where parallelism steps in: Note that (107) represents a way of instantiating all role-fillers of R to arrive at the proposition of the main clause. Since the arguments of R in the *than*-clause are Carol and s, in that order, only one of these (10) instantiations respects the pairing given to us by parallelism, the pairing of Carol with Jean and s with m. This, of course, is the solution for which Y is instantiated to Jean and D is instantiated to m.

$$\text{j gave sister(j) an } m \text{ expensive book} = R(j, m)$$

This is exactly (100). Thus (100) expresses something that follows from the presupposition of the *than*-clause given to us by the theory of focus and from our theory of parallelism.

Now consider solutions of (100):

(108)   (1) $\lambda y, d[y \text{ gave sister(j) a } d \text{ expensive book}]$
        (2) $\lambda y, d[y \text{ gave sister}(y) \text{ a } d \text{ expensive book}]$
        (3) $\lambda y, d[j \text{ gave sister}(y) \text{ a } d \text{ expensive book}]$
        (4) $\lambda y, d[j \text{ gave sister(j) a } d \text{ expensive book}]$
        (5) $\lambda y, d[y \text{ gave sister(j) a } \underline{m} \text{ expensive book}]$
        (6) $\lambda y, d[y \text{ gave sister}(y) \text{ a } \underline{m} \text{ expensive book}]$
        (7) $\lambda y, d[j \text{ gave sister}(y) \text{ a } \underline{m} \text{ expensive book}]$
        (8) $\lambda y, d[j \text{ gave sister(j) a } \underline{m} \text{ expensive book}]$

Of these eight solutions, the last six are eliminated in the theory of DSP by the requirement that both primary occurrences must be abstracted over. I will exclude (4)–(8) on the grounds that they vacuously abstract over one or more argument roles.

This leaves (3), also an incorrect solution. But (3) can be excluded on the grounds that it is inconsistent with the presuppositional requirements of (105). The inconsistency can be verified simply by plugging the value for R in each line into (105) constraint, and doing β-conversion:

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[21] There are ten parallel source equations because there are four free terms, and two roles to abstract into on the left-hand side. This would yield twelve equations, but two of the terms, sister(j) and j, cannot be simultaneously abstracted over.

$\exists x, m \in E[$ j gave sister(c) an s expensive book

$= x$ gave sister(x) an m expensive book or

$= x$ gave sister(j) an m expensive book]

There is no x that can change a giving in which Jean is the giver and Carol's sister is the recipient into one that is either an own-sister giving or one in which Jean's sister is the recipient.

The idea, then, is that if we let the theory of focus do part of the work of accounting for strict/sloppy readings, we can dispense with the idea of primary occurrences.

This completes the derivation of (100). It is worth reviewing the important assumptions and steps. First we adopted Rooth's contrastive analysis of comparatives and strengthened it to mutual contrast. Together with his presuppositional analysis of focus, this gave us two constraints on R, (105) and (106). Constraint (106) simply says S_7 expresses a proposition in some way parallel to the main clause. Invoking (106) and choosing the instantiation of Y and D that obeyed parallelism gave us (100). Invoking (105) eliminates a solution for R that, for DSP, was blocked by their restriction against solutions containing a primary occurrence. We thus see that the HOU machinery of Dalrymple, Shieber, and Pereira (1991) can be coupled very tightly with the kind of contrastive focus analysis of ellipsis sentences proposed in Rooth (1992).

The obvious direction to pursue in the future would be to make the general case that the theory of ellipsis is just the theory of focus plus a theory of parallelism.

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