

Comparative Sandwichology

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1. Introduction and Data

This paper points out some new observations regarding the truth conditions of *less*-comparatives, involving what are now known as SANDWICH SCENARIOS, as invoked originally in Sharvit and Stateva (2002) (henceforth S&S).

In S&S, sandwich scenarios provide the basis of a forceful argument for an individual based semantics of superlatives. A possible degree based alternative is dismissed, since it wrongly predicts a second reading for superlatives which isn't there.

The main observation in this paper is that S&S's argument regarding superlatives can be replicated for *less*-comparatives, contrary to S&S's own conclusion about comparatives. As a consequence, we should look for an analysis that captures both superlatives and comparatives alike.

Two such analyses are considered: A degree based one, along the lines of the one S&S dismiss because it overgenerates, and an individual based one, essentially S&S's superlative analysis adapted to comparatives.

The degree based analysis, it turns out, can derive the correct truth conditions, but always predicts a second reading which is unattested. The individual based semantics handles the simple cases correctly (and unambiguously), but has severe problems with more complex cases, including ones in which an ambiguity is in fact observed.

We are thus left with two incomplete proposals: the individual based analysis, which captures the superlative data nicely, but arguably fails to extent to the comparative case, and the degree based proposal, which treats comparatives and superlative alike, but too often generates an unattested reading.

2. Sandwich Scenarios

Here's a sandwich scenario: Suppose Sue, Mary and Bob each own a small plant that manufactures conversive carbon links (CCLs). In a search for the most efficient way to produce CCLs, the three have come up with various manufactur-

ing methods, which range from the rather expensive ‘immerse in gold’ (incurring costs of \$2.33 a piece) to the downright cheap ‘whack with a hammer’ (at \$0.03 a pop). CCL manufacturing being the highly competitive business that it is, the three competitors of course try to keep their methods secret, so not all are known to all. The situation is diagrammed in table 1 (as you see, there are also some other methods which are not as yet known).

method	\$ cost/piece	known to...		
		Bob	Mary	Sue
Uranium mold	88.00	-	-	-
immerse in gold	2.33	-	Y	-
heat to 500F	1.20	-	-	Y
coat with aluminum	.11	Y	-	-
whack with a hammer	.03	-	Y	-
use replicator	.008	-	-	-

Table 1: Methods, prices, and the people who know them.

This type of scenario is called sandwich scenario because the cost of the method that Bob knows is ‘sandwiched’ between the costs of two different methods that Mary knows.

2.1. Judgements for *more/most*

To warm up, what are the judgement for ordinary *more/most* comparatives and superlatives in this scenario? The following, quite clear pattern emerges (# here means ‘false’). (To aid judgement for the *more/most* cases, assume that for some reason it is desirable to incur high production costs, so the more expensive a method you know, the better — maybe think no-bid government contract.)

- (1)
 - a. Mary knows the most expensive method.
 - b. #Bob knows the most expensive method.
- (2)
 - a. Mary knows a more expensive method than every/anybody else.
 - b. #Bob knows a more expensive method than every/anybody else.
- (3)
 - a. Mary knows a more expensive method than Bob.
 - b. #Bob knows a more expensive method than Mary.

These judgments are predicted by any semantic theory of superlatives and comparatives that I know of. Yet, it is worth pointing out the following fact. Take (3b): Bob does know a method that is more expensive than *some* method Mary knows (he knows the ‘coat with aluminum’ method, which is more expensive than the ‘whack with a hammer’ method, which Mary knows). Yet (3b) is clearly false,

which indicates that *a more expensive method than Mary* is interpreted as (4a), not as (4b).

- (4) a. a method that is more expensive than *all* methods Mary knows
- b. #a method that is more expensive than *some* method Mary knows

2.2. Judgements for *less/least*

Let us now turn to *less/least*. The judgements for the scenario in table 1 are as follows (in this case, quite naturally, assume that knowing a cheap method is a good thing):¹

- (5) a. Mary knows the least expensive method.
- b. #Bob knows the least expensive method.
- (6) a. Mary knows a less expensive method than every/anybody else.
- b. #Bob knows a less expensive method than every/anybody else.
- (7) a. Mary knows a less expensive method than Bob.
- b. #Bob knows a less expensive method than Mary.

Again, we might expect (7b) to be true, since Bob knows a method ('coat with aluminum') which is less expensive than *a* method Mary knows ('immerse in gold'). Since (7b) is false, we conclude that *less expensive* must mean 'less... than all' rather than 'less... than some'.

So in sum *Bob knows a more/less expensive method than Mary* is true iff Bob knows a more/less expensive method than *all* methods Mary knows, not if Bob merely knows a more/less expensive method than *some* method Mary knows.

2.3. The Dilemma

The judgments provided above seem rather solid, but in the *less*-case, they differ from the predictions made by many standard, degree-based semantic proposals for comparatives. Assume that expensiveness is measured by a function *COST*, which maps each method onto its degree of expensiveness (roughly: its price). The *than*-clause in e.g. examples (3a)/(7a) above then denotes (8), the set of cost-degrees *d* s.t. Bob knows a method that is *d*-expensive or more than *d*-expensive:

$$(8) \quad \{d \mid \text{for some method } x \text{ that Bob knows, } d \leq \text{COST}(x)\} \quad \boxed{=D_{\text{than}}}$$

For Mary to know a *more* expensive method means that she knows some method whose cost-degrees are a superset of Bob's (i.e. D_{than}), (9):

- (9) Mary knows a more expensive method than Bob (does).
 Mary knows a method *y* s.t. $\{\lambda d \mid d \leq \text{COST}(y)\} \supset D_{\text{than}}$

Putting (9) and (8) together, we correctly derive that (3a) is true iff Mary knows a method that is more expensive than the *most* expensive method Bob knows.

Turning to the *less* comparative, the natural move seems to be to replace \supset in (9) by \subset , i.e. Mary knows a method whose cost degrees are a subset of Bob's:

- (10) Mary knows a less expensive method than Bob (does).
 Mary knows a method y s.t. $\{d \mid d \leq \text{COST}(y)\} \subset D_{\text{than}}$

Unfortunately, combining (10) with D_{than} from (8) above yields the wrong result: (7a) is predicted to be true iff Mary knows a method that is less expensive than the *most* expensive method Bob knows.

The problem is rooted in the semantics of the *than*-clause in (8), which only reflects the cost of the most expensive method Bob knows, regardless of which other methods he might know. What we need for the *less* comparative, however, is information about the *least* expensive method Bob knows. I will call this problem the COMPARATIVE SANDWICH DILEMMA. It is the same problem observed for *least*-superlatives in S&S — unsurprisingly, since one can simply think of the semantics of the superlative as a comparative (as in (8) above), with a variable ranging over all (relevant) COMPETITORS in place of 'Bob'.

3. A Solution Based on Negative Degrees

3.1. Basic Idea

One way to solve the sandwich dilemma is to assume that a *less*-Comparatives like (11a) is in fact interpreted as (11b) (see Heim, 2006; Kennedy, 2001; Rullmann, 1995; Seuren, 1978, 1984; von Stechow, 1984):

- (11) a. Mary knows a less expensive method than Bob.
 b. Mary knows a cheaper method than Bob

The cheapness of an object x , in the technical sense, is the set of degrees *above* its cost: $\{d \mid \text{COST}(x) < d\}$ (the complement of its expensiveness degrees); hence the lower its cost, the bigger its cheapness. To illustrate, the denotation of the *than*-clause in (7a) is now (12), the set of cost degrees above the cheapest method Bob knows (compare to (8) above):

- (12) ~~[[than Bob knows a cheap method]]~~ = $\{d \mid \text{for some method } x \text{ that Bob knows, } \text{COST}(x) < d\}$

Note that the shift from the most expensive to the cheapest comes about purely as a side effect of dealing in cheapness degrees, rather than expensiveness degrees. You can think of the denotation of the *than* clause as the union of the degree sets for each method Bob knows. The set of expensiveness degrees of the most

expensive method is a superset of the sets of expensiveness degrees of all cheaper methods, so the result is the expensiveness of the most expensive method. But the set of cheapness degrees of the *cheapest* method is a superset of each set of cheapness degrees of the more expensive (less cheap) methods, so that the union is the same as the cheapness of the cheapest.

Now if Mary knows a method whose cheapness degrees are a superset of (12) (i.e. a cheaper method), she knows a less expensive method than the cheapest one Bob knows. This yields the correct truth conditions for (7a).

3.2. Implementation (Sketch)

The implementation of this follows Heim (2006) and Buring (2007a,b). *Expensive* maps any object to the set of cost degrees lesser or equal to its costs; *LITTLE* maps a set of degrees to its complement, e.g. the expensiveness degrees onto cheapness degrees:

- (13) a. $\llbracket \text{expensive} \rrbracket = \lambda x_e. \{d_d \mid d \leq \text{COST}(x)\}$
 b. $\llbracket \text{LITTLE} \rrbracket = \lambda i_{dt}. \{d_d \mid \neg i(d)\}$
 c. $\llbracket \text{LITTLE expensive} \rrbracket = \lambda x. \{d_d \mid \neg [d \leq \text{COST}(x)]\}$
 $\equiv \lambda x. \{d_d \mid \text{COST}(x) < d\}$

The logical form for *less expensive method than Bob (does)* in (7a) is (14), where *more LITTLE expensive* gets spelled out as *cheaper* in the main clause, and *knows a LITTLE expensive method* is elided in the *than*-clause:

- (14) more [LITTLE expensive] method than Bob knows a [LITTLE expensive] method

3.3. Superlatives

The semantics sketched above can be extended to the superlative cases quite naturally. Intuitively, this is easy to see: the truth conditions of the superlative are the same as those of (15), repeated from (6a) above, which in turn is just the semantics for *Mary knows a less expensive method than Bob* with a generalized quantifier in place of Bob:

- (15) Mary knows a less expensive method than every/anybody else.

The truth conditions for *Mary knows the least expensive method* are thus the ones in (16) (recall that a method *m* is *d*-LITTLE-expensive iff $\text{COST}(m) < d$):

- (16) Mary knows a method *m*, and for all competitors *x* to Mary, $\{d \mid x \text{ knows a method which is } d\text{-LITTLE-expensive}\} \subset \{d \mid m \text{ is } d\text{-LITTLE-expensive}\}$

4. Individual Comparison

4.1. S&S's Proposal

Let us now turn to S&S's proposal to deal with sandwich scenarios in superlatives. The truth conditions they assume are given in (17):

- (17) *Mary knows the least expensive method* is true iff Mary knows the method which is less expensive than any other method in K

K in (17) is contextually instantiated as the set of methods Mary's competitors know. It is important to note that this COMPARISON SET consists of methods, not degrees of expensiveness. We then directly compare the cost of each method to that of Mary's method, and derive the correct truth conditions. I will henceforth refer to this type of analysis as INDIVIDUAL COMPARISON (as opposed to DEGREE COMPARISON).

S&S do not, however, propose an analogous, individual comparison semantics for the comparative; the interpretation they propose for *less*-comparatives instead is illustrated in (18):

- (18) *Bob knows a less expensive method than Mary* is true iff there is a degree d s.t. Bob knows a method which is *not* d -expensive, and Mary knows a method that *is* d -expensive

Applied to sandwich scenarios, this proposal suffers from the now well-known problem: it generates the 'less than some' reading; it thus predicts both of the following (and probably also (20)) to be true in the scenario in table 1:

- (19) a. Bob knows a less expensive method than Mary.
(true, because Bob knows the 'coat with aluminum' method, which is not as expensive as 'immerse in gold', which Mary knows)
b. Mary knows a less expensive method than Bob.
(also true, because Mary knows the 'whack with a hammer' method, which is not as expensive as 'coat with aluminum')
- (20) Mary and Bob each know a less expensive method than the other.

4.2. An Alternative (More Like S&S's Superlative Semantics)

Let us try to adapt S&S's individual based superlative analysis to the comparative case. The trick, recall, was to compare methods, rather than degrees. This is illustrated in (21):

- (21) *Bob knows a less expensive method than Mary* is true iff Bob knows a method which is less expensive than any other method in K , and $K = \{x \mid x$

is a method Mary knows}

(21) reflects the correct truth conditions. Now, evidently, *K* here is not contextually provided; it is given by the *than*-clause, which then must denote a set of individuals, rather than degrees:

(22) $\llbracket \text{than Mary (does)} \rrbracket = \{x \mid \text{Mary knows (method) } x\}$

It thus seems that we can give a semantics for the *less*-comparative that works fine in sandwich scenarios, and for the same reason S&S's analysis does for superlatives. But (21) can't in general be the correct logical form for attributive comparatives, as I will now show.²

4.3. *Than*-Clauses in Attributive Comparatives Can't Generally Denote Sets of Individuals

The semantics just given, generally, fails to work in any context in which the *than* clause contains a modal expression. Consider (23):

- (23) You bought a more expensive house than I thought you would.
- a. you bought a house which is *d*-expensive, and I didn't think you'd buy a *d*-expensive house.
 - b. *you bought a house which is more expensive than any house I thought you'd buy

With degree comparison, (23) is true if (23a) holds, which accords to intuitions. With individual comparison, however, its truth conditions are wrongly predicted to be those in (23b). To see what's wrong with that, note that in (23b), the *than*-clause denotes the set of houses that I thought you would buy. But in order for (23) to be true, I don't have to think about any particular house that you would buy it (I don't have to have a *de re* belief about any house at all). If I thought you'd spend \$400,000, and you bought one for \$600,000, (23) is true, even if I don't have the first idea of which houses \$400,000 could buy.

The same problem can be seen in (24):

- (24) You bought a more expensive gift than you had to.
- a. you bought a *d*-expensive gift and you didn't have to buy a *d*-expensive gift
 - b. *you bought a gift that was more expensive than any gift you had to buy

Clearly, (24) is true if you spent more money than was necessary; there doesn't have to be any particular gift you had to buy.

In conclusion then, *than*-clauses in DP-internal comparatives can't generally denote sets of individuals. Accordingly, DP-internal comparatives can't generally compare individuals. Individual comparison, then, can't be the solution to the comparative sandwich dilemma.³

5. Problem Not Quite Solved

At this point we have seen the following: The sandwich dilemma occurs in *least*-superlatives and *less*-comparatives alike. An interval-based semantics can handle the comparative cases, as well as the superlatives. S&S's proposal for superlatives, too, avoids the sandwich dilemma, but their proposal for comparatives doesn't. Adapting their superlative semantics, which is based on individual, rather than degree, comparison, to comparatives solves the sandwich dilemma, but is genuinely unable to handle modal operators in *than*-clauses. So on balance, the degree based semantics seems preferable.

There is, however, one problem with the degree comparison proposal (as S&S note in discussing a possible alternative to their superlative semantics). It works as long as it is assumed, crucially, that *less/least expensive* is necessarily interpreted as 'more/most cheap' (rather than 'less/least expensive'). But there is independent evidence that in fact either interpretation is available.⁴ Consider (25):

- (25) He drove less fast than he had to.
- a. his slowness is more than the slowness he has in every permitted world (he could have gone faster)
 $\{d \mid SPEED(@)(he) < d\} \supset \{d' \mid \forall w \in Deon(@), SPEED(w)(he) < d'\}$
 - b. his fastness is less than the fastness he has in every permitted world (he was too slow)
 $\{d \mid d \leq SPEED(@)(he)\} \subset \{d' \mid \forall w \in Deon(@), d' \leq SPEED(w)(he)\}$

(25a) corresponds to the analysis given in section 3. above: He drove slower than how slow he had to drive ('below the maximum'; note that we have $SPEED(he) < d$, and \supset ; @ stands for the world of evaluation, Deon maps every world to the worlds deontically accessible from it).

But (25) has a second, in fact more prominent reading, (25b): he drove too slow ('below the minimum'). This corresponds to interpreting *fast* as fast ($d \leq SPEED(he)$) and *less* as the inverse of (*more*) (\subset) (see Rullmann, 1995; Heim, 2006; Büring, 2007a,b, for more on these readings).

What this ambiguity suggests is that the interpretation of *less expensive* as 'more cheap' is optional; alternatively, and in fact preferably, it can be interpreted as 'not as (i.e. less) expensive'.

But crucially, the 'less fast'/'below the minimum' construal must not be avail-

able for attributive comparatives such as *a less expensive method than...*, and therein lies the problem for the degree based account proposed in section 3. above.⁵ If both construals were available, we would wrongly predict two readings, which are truth conditionally distinct in sandwich scenarios:

- (26) Mary knows a less expensive method than Bob does.
- a. less expensive = more cheap:
Mary knows a method y s.t. $\{d \mid \text{COST}(y) < d\} \supset \{d \mid \text{for some method } x \text{ that Bob knows, } \text{COST}(x) < d\}$
'(for some d) Mary knows a method that is d -cheap and it is not the case that Bob knows a method that is d -cheap'
 - b. #less expensive = less expensive
Mary knows a method y s.t. $\{d \mid d \leq \text{COST}(y)\} \subset \{d \mid \text{for some method } x \text{ that Bob knows, } d \leq \text{COST}(x)\}$
'(for some d) Mary doesn't know a method that is d -expensive and Bob knows a method that is d -expensive'

(26a) are the correct truth conditions. But (26b) gets us straight back to the untested 'less than some' reading (note that (26b) is true as long as Mary knows the most expensive method, regardless of whether she also knows the cheapest). And as usual, an individual-based semantics such as the one from section 4.2. above fares better here, since it doesn't generate the 'not as expensive' reading to begin with (the same is true for the superlative cases, as S&S discuss in their paper).

What are we to make of this? Two possibilities come to mind: An advocate of degree comparison may argue that the 'less expensive' construal is, for reasons yet unknown, unavailable in attributive comparatives. An advocate of individual comparison may take the lack of ambiguity as a further argument for having the *than*-clause denote individuals in attributive comparatives (which wouldn't predict any ambiguity), though not in adverbial ones such as (25) (and that the modal cases discussed in section 4.3. have to await an alternative analysis).

Unfortunately, neither of these seems feasible, for an ambiguity does arise if we combine an attributive comparative with a modal in the *than*-clause:

- (27) He bought a less expensive car than he could have (ten years ago).
- a. '(for some price) he bought a car that inexpensive, and (ten years ago) he couldn't have bought a car that inexpensive (he used to have to spend more money)' 'less than any'
 - b. '(for some price), he bought a car that wasn't that expensive, and he could have bought a car that expensive (he's modest)' 'less than some'

To bring out the two readings, first assume that ten years ago he had to spend a lot of money on cars (maybe he needed a prestigious car for his job, or maybe the

kind of car he needs just got a lot cheaper); this is described by reading (27a), the familiar ‘less than any’ reading (‘less expensive than any car he could have bought (in any permitted world) ten years ago’).

Alternatively, ignore the *ten years ago* in (27), and assume that he simply refrained from spending as much money on his new car as he could afford. This is reading (27b), the so far unattested ‘less than some’ reading (‘less expensive than some car he could have bought (in some permitted world)’).

Clearly, these cases are beyond the reach of the individual based analysis (which in fact can’t derive either reading, for the reasons discussed above), whereas the interval-based semantics predicts them correctly. We also see that whatever one would stipulate to block the ‘more cheap’ reading in an interval based account should not be too fundamental, since we need to ‘revive’ it in these modal cases.

6. Summary and Conclusion

There are two ways to avoid the Sandwich Dilemma in *least*-superlatives: Comparing individuals rather than degrees (Sharvit and Stateva, 2002), and comparing negative degrees.

What has not been noted in the literature is that the sandwich dilemma applies in *less*-comparatives just the same as in superlatives (*pace* S&S’s claim). Whatever route one chooses to analyze the *least*-superlative should therefore be viable for *less*-comparatives as well.

S&S’s own semantics for comparatives yields incorrect truth conditions in sandwich scenarios. A treatment more along the lines of their superlative semantics can be devised. But it runs into severe problems with intensional contexts.

The degree-based semantics gets the right truth conditions in *less*-comparatives, but predicts an ambiguity (both in comparatives and superlatives) which isn’t there.

Clearly, more research is needed. Either the individual comparison approach needs to be augmented to extend better to modal cases, or the degree comparison approach must be restricted to exclude the ‘less expensive’ reading in simple comparatives.

Notes

¹S&S draw a different conclusion, essentially that the truth conditions for *less*-comparatives are unclear or controversial; this, I submit, is an artefact of their particular examples, which are pragmatically rather odd, and not at all representative of the whole class.

²I say ‘for attributive comparatives’, because it is easy to see that *than*-clauses can’t generally denote sets of individuals; two counter examples are given in (28):

- (28) a. You know this better than I do.
b. The tree is taller than the ladder is long.

There are no individuals that would be candidates for the denotation of the *than*-clause in (28a), and it seems clear that the *than*-clause in (28b) contains its own measuring function, denoted by *long*, and hence denotes a set of degrees. But the sandwich dilemma doesn't seem to arise in adverbial comparatives, and comparative sub-deletion seems bad in adnominal comparatives. . .

- (29) a. ?They sit on a longer pole than we have a ladder.
 b. *They live on a taller tree than we have a long ladder.

. . . one could maybe claim that at least *attributive* comparatives always have individual type gaps.

³Sharvit and Stateva (2002) note a problem for superlatives — the so-called *upstairs de dicto* reading — which may be the superlative counter-part of the problems discussed here. Whether it really is, and whether their approach to the superlative could be imported to the comparative case is not clear to me.

⁴The discussion here is phrased in terms of *less/least expensive* being ambiguous between 'more/most cheap' and 'less/least expensive'. Alternatively, it can be seen as a matter of scope ambiguity for the operator LITTLE, as is done in Heim (2006) and S&S. Nothing in the discussion hinges on this choice, see also the references in the main text.

⁵Some speakers have a difficult time getting the 'below the maximum' reading for (29) at all. The following naturally occurring examples, however, suggest that this reading is in fact possible:

- (30) a. "In the late 90s, most towns didn't need all that money so they taxed **less than they had to**. As things got bad, they cranked it into the red and started collecting every last tax dollar they could." (<http://www.bluemassgroup.com/showDiary.do?diaryId=4905>)
 b. "The landlord was really nice to me. [...] He's old Brooklyn, Italian. It seemed too good to be true. [...] When the rent was supposed to go up, he raised it **less than he had to**." (<http://www.villagevoice.com/nyclife/0550,schlesinger,70894,15.html>)
 c. "If you choose a mystery shopping company that does not allow you and your team secure and remote access to data 24/7, you will be settling for much **less than you have to**." (<http://www.coylehospitality.com/mystery-shopping/mystery-shopping-service.asp>)
 d. "Let's face it: you are probably working for far **less than you need to**." (http://www.articlecity.com/articles/business_and_finance/article_8365.shtml)

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