Comparative and Equative Correlatives as Anaphora to Differentials

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1 Comparative and Equative Correlatives in Romanian

The presentation[1] has **two empirical goals**:

i. to establish that there are comparative correlatives (*a*) that are not comparative conditionals, against what much of the previous literature (e.g. Beck 1997) assumes and (*b*) that the semantics of such correlatives crucially involve a relation (possibly the identity relation) between differentials – again, against what some of the previous literature (e.g. Beck 1997) assumes

Correlatives: "biclausal topic-comment structures […] [in which] the dependent clause introduces one or more topical referents to be commented on by the matrix clause, where each topical referent must be picked up by – correlated with – an anaphoric proform." (Bittner 2001)

Differentials: *2 inches*, for example, is a differential in the comparative *Gabby is two inches taller than Linus* because it specifies the difference between Gabby's and Linus' height.

This is shown by the following Romanian comparative correlative (note the overt *than* phrases, not usually acceptable in English):

1. Cu cît e mai înalt fratele decît sora, (tot) cu atît e mai înalt tatăl decît mama.
With how much is more tall brother.the than sister.the, (also) with that much is more tall father.the than mother.the
'The brother is taller than the sister by a certain amount and the father is taller than the mother by the same amount.'

Intuitively, sentence (1) is true iff:

- the brother is taller than the sister and the father is taller than the mother – that is, there is *no conditionality* (no "if the brother is taller than the sister …" kind of interpretation)
- the difference in height between the brother and the sister is the same as the difference in height between the father and the mother (this is particularly clear if the particle *tot* (also) is present) – i.e. the correlative *equates the two differentials* under consideration

The non-conditionality of correlatives is further supported by the following equative correlative:

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2. Pe cît e Irina de frumoasă, (tot) pe atît e de deşteaptă.
PE how much is Irina DE beautiful, (also) PE that much is DE smart
'Irina is beautiful to a certain, significant extent and she is smart to the same, equally significant extent.'

On its most salient reading, sentence (2) is true iff:

- Irina is (significantly) beautiful and (significantly) smart[2]
- the extent to which Irina is beautiful and the extent to which she is smart are (in some sense) equated / similar / comparable

ii. to establish that a unified analysis should be given for such non-conditional, differential-based comparative (and equative) correlatives and for the more familiar, conditional-like comparatives

This is shown by the sentences in (3) and (4) below, which have the same basic syntax (except for the overt vs. covert *than* phrases) and the same morphology (a wh-indefinite in the topic clause and an anaphoric demonstrative in the comment clause) as sentence (1) above.

3. Cu cît e un avocat mai agresiv, cu atît e mai eficient.
With how much is a lawyer more aggressive, with that much is more efficient
'The more aggressive a lawyer is, the more efficient s/he is.'

4. Cu cît e un număr natural mai mare decît altul,
With how much is a number natural more great than another,
(#tot) cu atît e pătratul lui mai mare decît pătratul celuilalt.
(#also) with that much is square.the it.Gen more great than square.the other.one.Gen
'The greater one natural number is (than another), the greater its square is (than the square of the other one).'

Moreover, the interpretations of (3) and (4) are very closely related to the interpretation of (1).

Intuitively, sentence (3) has two salient readings – it can be paraphrased by either the conditional in (*a*) or the one in (*b*) below (as Beck 1997 points out with respect to very similar examples in German):

a. if a lawyer x is more aggressive than a lawyer y by a certain amount, then x is more efficient than y by a corresponding amount.

b. if a lawyer x is more aggressive at time t than at time t' by a certain amount, then x is more efficient at time t than at time t' by a corresponding amount.

As (*a*) and (*b*) above indicate, such conditional-like comparative correlatives crucially involve a relation between differentials, just as the non-conditional correlative in (1) does.

[2] This meaning component is not necessarily present in equative correlatives and it is systematically absent in certain cataphoric equative correlatives (where the clause containing the anaphoric demonstrative precedes the clause containing wh-indefinite second). For example, if I am asked about criteria for estimating the age of a tree, I can say *Un copac e pe atît de bătrîn pe cît e de gros* (A tree is as old as it is thick), which applies to all trees, including the very young and thin ones.

This is most clearly shown by the interpretation of sentence (4) when the particle *tot* (also) present – (4) iff:

- for any two natural numbers *m* and *n* such that *m* is greater than *n*, the difference *m–n* is *identical* to the difference between their squares $m^2–n^2$

That is, (4) with the particle *tot* is true iff $\forall m\in\mathbb{N}\forall n\in\mathbb{N}(m>n \rightarrow m–n=m^2–n^2)$, which is why (4) with *tot* is intuitively false. This intuitive falsity cannot be derived if (4) does not involve a relation between differentials, which is forced by the particle *tot* to be the identity relation.

In contrast, (4) without the particle *tot* is intuitively true because it simply requires that:

- for any two natural numbers *m* and *n* such that *m* is greater than *n*, the positive difference *m–n* corresponds to a positive difference between their squares $m^2–n^2$

In this case, for a given *n*, the correspondence is an increasing function $f(m–n)=m^2–n^2$, but in general, the correspondence does not have to be increasing or even functional in nature.

The second point is further supported by the conditional equative correlative in (5) below, the interpretation of which is roughly similar to the interpretation of the comparative correlative in (3).

However, the interpretation of such conditional equatives correlatives is more constrained than the interpretation of the corresponding conditional comparative correlatives. For example, the equative in (6) below is not acceptable, in contrast to its comparative counterpart in (4) above: intuitively, the equative correlative in (6) falsely equates a natural number *m* and its square m^2, for any natural number *m*.

5. Pe cît e de agresiv un avocat, pe atît e de eficient.
PE how much is DE aggressive a lawyer, PE that much is DE efficient
'The aggressiveness of a lawyer is proportional to her/his efficiency.'

6. #Pe cît de mare e un număr natural, pe atît de mare e pătratul lui.
#PE how much DE great is a number natural, PE that much DE great is square.the it.Gen
'#A natural number is equal to its square.'

Thus, the **main goal** of the presentation is:

iii. to provide a unified account of the semantics of both kinds of comparative correlatives (conditional and non-conditional) that crucially involves a relation between differentials

Excursus: the choice of preposition in Romanian comparative vs. equative correlatives – *CU* vs. *PE*

- the comparative correlative preposition *cu* (with) is used with instruments, as shown in (7) below – this is very similar to the use of the instrumental preposition *by* (e.g. *dead by knife*) with differentials in English (e.g. *Lucius is taller than Cornelius by a head*) and reinforces the connection between the Instrumental case and differentials in comparative correlatives observable in various other languages – see den Dikken (2005) for instrumental-marked differentials in Old English, Russian and Hungarian; in Latin, for example, the differential appears in Ablative, the Latin case that incorporates the Proto-Indo-European Instrumental case: *Lucius capite altior est quam Cornelius*

7. Am = tăiat pîinea cu cuţitul.
Have.1sg = cut bread.the with knife.the
'I cut the bread with the knife.'

- the equative correlative preposition *pe* (on) has many uses (including differential object marking), but two of them are directly relevant: (*a*) *pe* is a locative preposition, as shown in (8) below; *pe* in such constructions can be taken to retrieve that part of the table that has the highest degree of height (its surface) – an interpretation closely related to the one that *pe* has in the equative correlative in (2); (b) *pe* occurs with measure expressions in the non-correlative constructions in (9), (10) and (11) below, with a similar "maximal degree" interpretation, as shown by the English translations

8. Cartea e pe masă.
Book.the is on table
The book is on the table.

9. Sticla e goală pe trei sferturi / pe jumătate.
Bottle.the is empty PE three quarters / PE half.
'The bottle is three quarters / half empty.'

10. Linus era pe jumătate dezbrăcat.
Linus was PE half undressed
'Linus was half naked.'

11. Linus şi = a = făcut treaba doar pe jumătate.
Linus refl.DAT= HAS = done work.the only PE half.
'Linus only did half of his work.'

2 Comparative and Equative Correlatives as Anaphora to Differentials

The **basic proposal**:

- the Romanian *atît* (that much) in (1)/(2) is anaphoric to differential intervals, i.e. *atît* is a proform in the degree domain
- the wh-differential *cît* (how much) in (1)/(2) is an indefinite introducing a non-empty interval, anaphorically retrieved by *atît*

The idea that *atît* is an interval-based proform is supported by its anaphoric use in (12) below (compare with (1)), by its deictic use in (13) and its cataphoric use in (14).

12. Fratele e mai înalt decît sora cu 2 cm, iar tatăl e mai înalt decît mama tot cu atît.
Brother.the is more tall than sister.the with 2 cm, and father.the is more tall than mother.the also with that much
'The brother is 2 cm taller than the sister and the father is taller than the mother by the same amount.'

13. E atît de obosită.
Is that much DE tired.f.sg
'She is so tired.'

14. E atît de obosită încît o = doare capul.
Is that much DE tired.f.sg that her.Acc = hurts head.the
'She is so tired that she has a headache.'

Thus, the basic account captures the parallel between the interpretations of correlatives in the degree and individual domains, illustrated by:

a. the 'singular' / referential correlative in (15) below, which is parallel to (1) and (2): we refer to a single individual or a single differential interval or a single pair of differential intervals

b. the 'plural' / quantificational correlative in (16) below, which is parallel to (3) and (4): we refer to a set of individuals or a set of differential intervals or a set of pairs of differential intervals

See Dayal (1996), Bittner (2001), Bhatt (2003) and Brasoveanu (2008) for more discussion of individual-based correlatives.

15. Care fată şi = a = uitat ieri haina, pe aceea o =caută tatăl ei.
Which girl her.Dat = HAS = forgotten yesterday coat.the, PE that one her.Acc=look for father.the her.Gen
'The father of the girl that forgot her coat yesterday is looking for her.'

16. Pe care om l = a = interogat Securitatea, în acela nu am încredere.
PE which person him.Acc = HAS = interrogated security.the, in that one not have.1sg trust
'I do not trust any person (whatsoever) that the secret police interrogated.'

Extending the investigation of anaphoric (and quantificational) parallels across domains initiated in Partee (1973, 1984) to encompass the degree domain is further supported by the following English examples:

17. Donkey anaphora:
a. Every child that ate a lot of vanilla ice cream yesterday ate twice as much chocolate ice cream today.
b. Every farmer who owns a donkey beats it. (Geach 1962)

18. Quantificational subordination:
a. Harvey eats a lot of vanilla ice cream at every convention, but Linus always eats twice as much chocolate ice cream.
b. Harvey courts a woman at every convention. She always comes to the banquet with him. (Karttunen 1976)

19. Modal subordination:
a. Harvey might bring a lot of vanilla ice cream to the party tomorrow. In which case Linus would get competitive and bring twice as much chocolate ice cream.
b. A wolf might come in. It would eat you first. (Roberts 1987)

20. Topicalization:
a. As smart as Linus is, Gabby is even smarter.
b. Megan, I like her.

Thus, the non-conditional comparative correlative in (1) relates *two cases* (in the terminology of Lewis 1975; we could just as well use the situation-based terminology of Heim 1990):

- each case features two heights and their differential
- the two cases are related by means of the two differentials – and the differentials are equated

The conditional comparative correlatives in (3) and (4) are just a generalization of this basic pattern:

- they do not involve a single pair of cases related by means of their respective differentials, but involve multiple pairs of such cases
- what is characterized in the literature (following McCawley 1988) as the *conditionality* of comparative correlatives is just the fact that they correlate *sets* of cases and not single cases
- given a suitable framework, even run-of-the-mill conditionals like *If a wolf came in, it would / might eat you first* can be analyzed as correlative structures involving sets of cases (see Brasoveanu 2007, building on proposals in Stone 1999 and Bittner 2001)
- the only difference between comparative correlatives and ordinary conditionals is that the former correlate cases by means of differentials, while the latter correlate cases by means of the possible scenarios they evoke – hence the conditionality / hypothetical reasoning present in the latter, but not necessarily in the former (as (1) shows)

3 Formalizing Anaphora to Differentials in Compositional Dynamic Semantics

The degree-based correlatives in (1) and (2) are analyzed as instances of anaphora between the wh-indefinite *cît* and the anaphoric demonstrative *atît* (see Jespersen 1965/1924 and den Dikken 2005 for related ideas).

Given the syntactically non-local, cross-clausal character of such anaphora to intervals – which makes it similar to donkey anaphora –, the proposal is formalized in a dynamic semantics system. Following Muskens (1996), the system is couched in classical type logic, which delivers Montague-style compositionality at sub-clausal level by the usual methods.

In particular, we have four basic types

- the usual types e and t (individuals and truth-values)
- a basic type γ (from the Latin *gradus*) for degrees; d, d' etc. are variables of type γ
- a basic type s, whose elements model variable assignments; i, j etc. are variables of type s

Discourse referents (drefs):

- individual-denoting indefinites introduce – and the corresponding proforms anaphorically retrieve –drefs u, u' etc. for individuals, which are of type se

That is, drefs are modeled as individual concepts: intuitively, the individual $u(i)$ – or ui for short – is the individual that the dref u denotes relative to the assignment i.

- we also have drefs for degrees δ, δ' etc. of the expected type $s\gamma$
- finally, we have drefs for intervals (convex sets of degrees) Δ, Δ' etc. of type $s(\gamma t)$

A sentence is interpreted as a DRS / box, i.e. as a relation of type $s(st)$ between an input and an output assignment.

For example, the DRS $[u, \delta \mid tall\{u, \delta\}]$ abbreviates:

- $\lambda i.\lambda j.\ i[u, \delta]j \wedge tall\{u, \delta\}j$
- that is, the relation between an input assignment i and an output assignment j such that **(***a***)** i differs from j at most with respect to the values assigned to the newly introduced drefs u and δ (note that $[u, \delta]$ is itself a relation of type $s(st)$);
  (*b***)** the condition $tall\{u, \delta\}$ is satisfied by the output assignment j

Conditions denote sets of assignments (of type st).

For example, $tall\{u, \delta\}$ abbreviates (in the footsteps of the Montagovian brace convention):

- $\lambda i.\ tall(ui, \delta i)$
- that is, the set of assignments i such that the individual ui is tall at least to degree δi

Finally, DRSs without new drefs are interpreted as tests, e.g. $[tall\{u, \delta\}] := \lambda i.\lambda j.\ i{=}j \wedge tall\{u, \delta\}j$.

Example (1) above is interpreted as shown in (21) below:

- the comparative morpheme *mai* is interpreted as relating two definite descriptions over degrees (I've chose this interpretation to facilitate the comparison with Beck 1997, but this is not crucial to the analysis)
- the definite descriptions are represented by means of a DRS of the form $\delta{=}\text{MAX}(D)$, defined in (22) below
- for example, $\delta{=}\text{MAX}([tall\{u_{bro}, \delta\}])$ introduces a new dref δ and stores in it the maximal degree to which the brother u_{bro} is tall, i.e. his height
- the indefinite differential *cu cît* updates the discourse context by introducing an interval dref Δ, which the comparative morpheme equates with the difference between the height δ of the brother and the height δ' of the sister
- the comment / matrix clause in (1) receives a parallel interpretation, except that the differential *cu atît* anaphorically retrieves the interval Δ and equates it with the differential interval Δ' representing the difference between the father's height δ'' and the mother's height δ'''
- the updates in (21) are connected by means of dynamic conjunction ';', which is interpreted as relation composition, as shown in (23)

21. (TOPIC) $\delta{=}\text{MAX}([tall\{u_{bro}, \delta\}]);\ \delta'{=}\text{MAX}([tall\{u_{sis}, \delta'\}]);\ [\Delta \mid \Delta{=}\delta{-}\delta'];$
(COMMENT) $\delta''{=}\text{MAX}([tall\{u_{fa}, \delta''\}]);\ \delta'''{=}\text{MAX}([tall\{u_{mo}, \delta'''\}]);\ [\Delta' \mid \Delta'{=}\delta''{-}\delta'''];\ [\Delta{=}\Delta']$

22. $\delta{=}\text{MAX}(D) := \lambda i.\lambda j.\ ([\delta]; D)ij \wedge \forall k(([\delta]; D)ik \rightarrow \delta k{\leq}\delta j)$, where D is a DRS (of type $s(st)$)

23. $D; D' := \lambda i.\lambda j.\ \exists h(Dih \wedge D'hj)$

24. $\Delta{=}\delta{-}\delta' := \lambda i.\ \Delta i{=}\{d{:}\ \delta' i{<}d{\leq}\delta i\}$

The equative correlative in (2) is analyzed in terms of anaphora to the interval obtained by subtracting the (contextual) standard of beauty from Irina's maximal degree of beauty. This interval is correlated with the one obtained by subtracting the standard of smartness from Irina's maximal degree of smartness.[3]

Conditional comparative correlatives like (3) and (4) involve anaphora to *sets* of differential intervals and relations between sets of pairs of cases – which we can formalize by generalizing the dynamic system and letting it update sets of variable assignments (type st) instead of single variable assignments (type s). Such a move is independently motivated by the analysis of individual-based correlatives in Brasoveanu (2008).

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[3] Equative correlatives that do not involve reference to contextual standards, e.g. the correlative mentioned in fn. 2 above, correlate the intervals between the 0-points on the relevant scales and the maximal degree in the case under consideration.