

# Uniqueness Effects in Correlatives

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UC Santa Cruz – January 16, 2008

## 1 Introduction

The background question: what is the nature of reference and quantification in natural language?

Understanding these two notions is essential to understanding what natural language interpretation is. Consider, for example, the following discourse: *No animal should ever jump up on the dining-room furniture unless absolutely certain that he can hold his own in the conversation* (Fran Lebowitz). In one sentence, we refer to possibilities (*should ... unless*), quantify over individuals (*no animal*), refer to (kinds of) individuals (*the dining-room furniture*), quantify over eventualities (*ever jump*) and spatial locations (*on the ...*), refer to measures (*absolutely certain*) etc.

Traditionally, we classify natural language expressions following the lead of classical (first-order) logic:

	classical (first-order) logic	natural language
referential expressions	individual constants free variables	proper names anaphoric / deictic pronouns / demonstratives
quantificational expressions	universal / existential quantifiers	<i>every girl, no king</i> etc.

But natural language expressions do not readily fit into these two categories:

- i. not clear whether DPs like *a cabbage, the window, which boy* etc. are quantificational or referential
- ii. referential expressions can be interpreted quantificationally: the pronoun *it* in (1) is basically interpreted as shown in (2)

1. Every farmer who owns a<sup>x</sup> donkey beats it<sub>x</sub>. (Geach 1962)
2. Every farmer who owns a donkey beats *every donkey s/he owns*.

[indices: superscripts on antecedents, subscripts on anaphors; determiners and not whole DPs are indexed because the non-det. elements can be part of both antecedents and anaphors, e.g. *a / every frog* vs. *the / this / said frog*]

- iii. quantificational expressions have a referential component: the pronoun *they* in (3b) refers back to the quantifier *every boy* in (3a); similarly, in (4), *he* and *it* refer back to *which boy* and *which poem*
3. a. Every boy chose a poem. b. Then, they recited it.
  4. Which boy chose which poem and did he recite it?

We will focus on a kind of construction that exhibits both referential and quantificational properties, namely **correlatives**, in two much less studied languages, namely Hindi and Romanian.

## 2 The Phenomenon: Uniqueness Effects in Correlatives

**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)

**Single wh-topic correlatives:**

**5. definite interpretation – Hindi** (based on Dayal 1996):

jo laRkii lambii hai, vo khaRii hai.  
which girl tall be.prs, that one standing be.prs  
*The one girl that is tall is standing.*

**6. definite interpretation – Romanian:**

Care fată și =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.*

**7. universal interpretation – Romanian:**

Pe care om l =a =interogat Securitatea, în acela nu =mai =am încredere.  
PE which person him.Acc=HAS=interrogated security.the, in that one not=anymore=HAVE.1sg trust  
*Any person interrogated by the secret police is not trustworthy anymore, as far as I'm concerned.*

**Multiple wh-topic correlatives:**

**8. mixed universal & definite interpretation – Hindi** (Dayal 1996):

jis laRkii-ne jis laRke-ke saath khel-aa, us -ne us -ko haraa-yaa.  
which girl-Erg which boy-with together play-pfv, that one-Erg that one-Acc defeat-pfv  
*Every girl that played against a boy is such that (she played against exactly one boy and) she defeated the one boy she played against.*

**9. universal interpretation – Romanian:**

Cine ce mîncare și =a =adus, pe aceea o =va =mînca.  
Who what food REFL.Dat=HAS =brought, PE that one it.Acc =WILL.3sg =eat  
*Everyone will eat whatever food they brought with them*<sup>1</sup>.

**The problem:** account for the variability of the uniqueness implications associated with Romanian and Hindi correlatives, i.e. for their definite / unique vs. universal / non-unique interpretation.

Accounting for the equivocally referential (definite) and quantificational (universal) nature of correlative constructions will hopefully throw some light on our overarching background question.

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<sup>1</sup> A more colloquial and more natural variant is: *Cine ce și-a adus, aia o să mînce* (Everyone will eat whatever they brought).

### More specifically, why are correlatives interesting?

I. They are relevant for **syntax/semantics-interface** theories: correlatives have a quantifier binding semantics without syntactic c-command – just like donkey sentences, e.g. (1) above.

The basic syntactic structure of Hindi correlatives (from Dayal 1995; see Bhatt 2003 for a recent discussion) and, for all intents and purposes, Romanian correlatives is:

10. [IP [CP which girl is standing ] [IP that one is tall ] ]

This is closely related to the syntax of topicalization constructions like:

11. Maureen, I like her.

The contrast between (12) and (13) shows that we need c-command for quantifier binding – but not for donkey anaphora, as (14) shows.

12. Every<sup>x</sup> boy recommended a book to his<sub>x</sub> friends.

13. #Every boy who read every<sup>x</sup> *Harry Potter* book recommended it<sub>x</sub> to his friends.

14. Every boy who read a<sup>x</sup> *Harry Potter* book recommended it<sub>x</sub> to his friends.

II. Correlatives are relevant for **semantic/pragmatics-interface** theories: they display variable uniqueness effects, i.e. a universal vs. definite variation in interpretation, both within a particular language and across languages.

### Variation within a particular language:

- i. compare single- and multiple-topic correlatives in Hindi: *jo laRkii / jis laRkiine* (which girl) receives a definite / unique interpretation in the single-topic correlative in (5) and a universal / non-unique interpretation in the multiple-topic correlative in (8)
- ii. compare the two Romanian single-topic correlatives: (6) has a definite / unique interpretation – it is infelicitous if there is more than one contextually salient girl who forgot her coat; (7) has a universal / non-unique interpretation – it is felicitous in the actual world, where (obviously) more than one person was interrogated by the secret police

The definite correlative in (6) and the universal correlative in (7) are not morpho-syntactically different: in both cases, the subordinate clause is eventive *passé composé* and the matrix clause is stative present. That is, the difference in their interpretation is not due to their temporal-aspectual structure, e.g. generic present (*A dolphin eats fish and squid*) vs. episodic past (*A dolphin ate fish and squid*).

**Generalization:** the variation in the interpretation of Romanian single-topic correlatives is a pragmatic matter. We deal with regular, habitual phenomena in (7) and accidental, sporadic events in (6) – and it is world knowledge, i.e. an extra-linguistic, pragmatic factor, that enables us to make this distinction.

### Variation across languages:

- i. **single-topic correlatives:** the contrast between the Romanian examples in (6) and (7) is overtly marked morphologically in Hindi – single-topic correlatives have a universal reading if we switch from episodic to habitual morphology (Dayal 1995):

15. jo laRkii lambii **ho-tii** hai, vo khaRii **ho-tii** hai.  
which girl tall be-hab.f be.prs, that one standing be-hab.f be.prs  
*A tall girl (generally) stands (e.g. in buses where there isn't enough leg room between the seats).*

An informant remarked that, intuitively, (15) generalizes over situations in which there is a unique girl who is tall. About each such situation, we predicate that the girl in it stands.

- ii. **multiple-topic correlatives:** they have an across-the-board universal interpretation in Romanian; they have a mixed universal & definite interpretation in Hindi – the initial topic receives a universal interpretation and all the other topics are unique relative to each value of the initial topic.

### Two problems:

- i. **compositionality (syntax/semantics):** capture the range of readings correlatives have, in particular the fact that the universal, quantificational reading does not require c-command

This is solved by taking a dynamic approach, specifically designed to compositionally derive syntactically non-local quantificational dependencies like donkey anaphora (see appendix).

- ii. **uniqueness effects (semantics/pragmatics):** account for the intra- and cross-linguistic variation in interpretation exhibited by correlatives, in particular for the semantics of habitual morphology in Hindi and the pragmatics of quantification at work in Romanian

We focus on single-topic correlatives (for expository reasons).

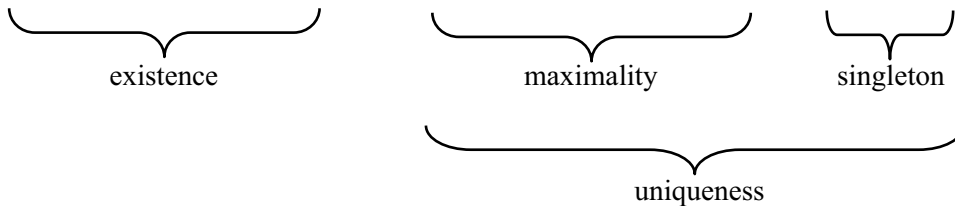
### 3 The Analysis: Maximal Wh-Indefinites and Fine/Coarse-Grained Quantification

#### How does the definite / unique interpretation arise?

The Russellian analysis of a definite description like *the chair Leif brought* in (16) derives its uniqueness by putting together a maximality requirement and a singleton requirement:

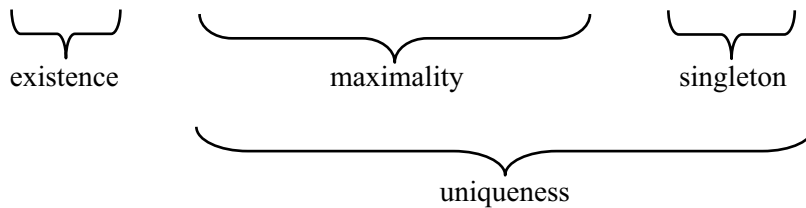
16. The chair Leif brought is wobbly.

17.  $\exists x[\text{chair}(x) \wedge \text{bring}(\text{leif}, x)] \wedge \forall y[\text{chair}(y) \wedge \text{bring}(\text{leif}, y) \rightarrow y=x] \wedge \text{wobbly}(x)$



This analysis can be alternatively represented in terms of set variables:

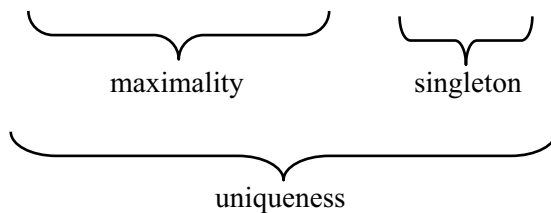
18.  $\exists X[ X \neq \emptyset \wedge X = \{y : \text{chair}(y) \wedge \text{bring}(\text{leif}, y)\} \wedge |X| = 1 \wedge \text{wobbly}(X) ]$



**The basic proposal:** the definite / unique interpretation of Hindi and Romanian correlatives arises as a consequence of (i) the maximality contributed by the wh-indefinite in the topic / subordinate clause, together with (ii) the singleton requirement contributed by the singular demonstrative in the comment / matrix clause.

19.  $\text{jo}^X \text{ laRkii lambii hai,} \quad \text{vo}_X \quad \text{khaRii hai.}$   
 which girl tall be.prs,      that one      standing be.prs

$\exists X[X \neq \emptyset \wedge X = \{y : \text{girl}(y) \wedge \text{tall}(y)\} \wedge |X| = 1 \wedge \text{standing}(X)]$



Note that we do NOT conflate Russellian definites (or universal quantifiers) and maximal indefinites:

- **definites** maximize only over their restrictor property (the same thing happens with universal quantifiers), i.e. we extract the set of individuals satisfying the restrictor property, and check that this set is a singleton and that it satisfies the nuclear scope property
- **maximal indefinites** maximize over both the restrictor and the nuclear scope property, i.e. we extract the set of individuals satisfying both of them, and we check that this set is non-empty.

Thus, definites and maximal indefinites differ with respect to: (i) whether or not **maximization** 'includes' the nuclear scope property; (ii) whether or not the **singleton** requirement is part of their meaning.

The way we use maximal indefinites becomes clearer if we look at a related phenomenon in English: the uniqueness effects associated with cross-sentential anaphora to singular indefinites. Consider:

20. Leif has a chair. (Kadmon 1990)

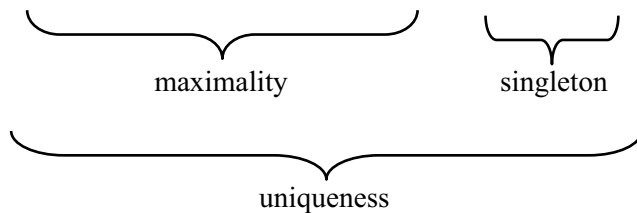
21. a. Leif has a chair. b. It is in the kitchen. (Kadmon 1990)

"Suppose I need to borrow a chair [...] Leif has ten identical chairs, and he is willing to lend any of them. You can now say [(20)] to me [...]. In this situation, the NP *a chair* does not refer to a unique chair. [...] When anaphora is attempted, however, the uniqueness effect always shows up. Consider [(21)] in the same situation, and be sure that you are completely unable to distinguish any one of Leif's chairs from his other chairs. [...] Many speakers cannot use [(21)] in such a situation. For these speakers, [(21)] is only felicitous [...] [if] they are referring to a chair which is uniquely identified by some property [...]."  
(Kadmon 1990)

Here's how these uniqueness effects can be derived in terms of maximal indefinites (Kadmon 1990 proposes a different analysis):

22. Leif has a<sup>X</sup> chair. It<sub>X</sub> is in the kitchen.

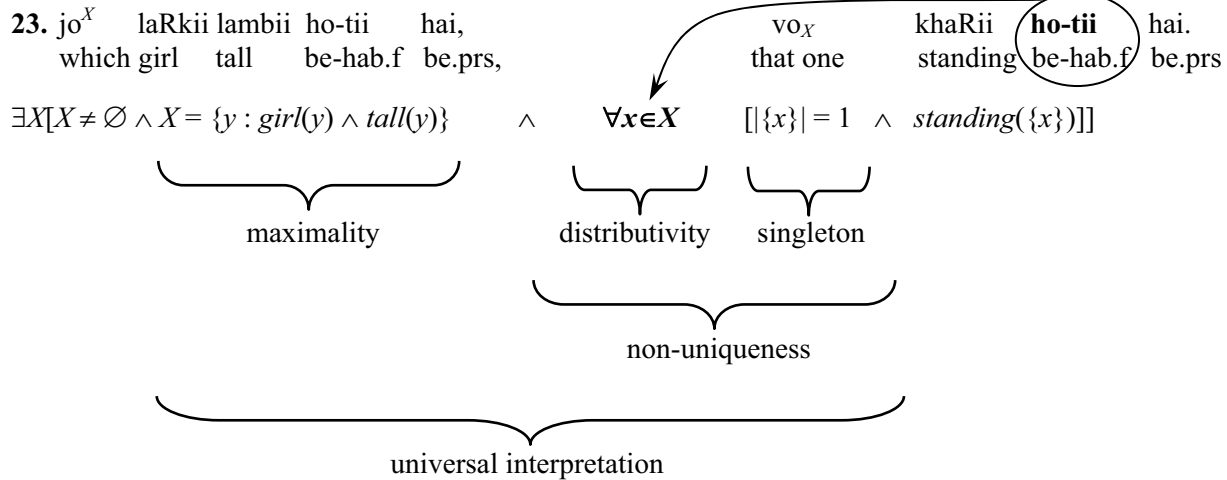
$\exists X[X \neq \emptyset \wedge X = \{y : \text{chair}(y) \wedge \text{have}(\text{leif}, y)\} \wedge |X| = 1 \wedge \text{in\_kitchen}(X)]$



Thus, singular cross-sentential anaphora provides independent justification for the proposed analysis of uniqueness effects in correlatives.

## How does the universal / non-unique interpretation arise?

**The basic proposal:** the universal / non-unique interpretation of Hindi and Romanian correlatives arises by interposing a distributivity operator between (i) the maximal wh-indefinite in the subordinate clause and (ii) the singleton requirement contributed by the singular demonstrative in the matrix clause.



Thus, the distributivity operator contributed by habitual morphology neutralizes the singleton requirement contributed by the singular anaphor. So, the maximality of the wh-indefinite delivers the desired universal / non-unique interpretation.

## But why would habitual morphology contribute a distributivity operator over individuals?

Well, it doesn't – habitual morphology contributes **distributivity over cases / situations**.

Recall the informant's comment: the habitual correlative in (15) generalizes over situations in which there is a unique girl who is tall; about each such situation, we predicate that the girl in it stands.

Here are some English discourses that exhibit a similar kind of distributivity, i.e. in which we 'zoom in' on each case / situation under consideration:

24. Every chess set comes with a<sup>x</sup> spare pawn. It<sub>x</sub> is taped to the top of the box. (Sells 1985)  
 [for each case / situation featuring a chess set and a spare pawn: the pawn in the case / situation under consideration is taped to the top of the box]
25. Harvey courts a<sup>x</sup> woman at every convention. She<sub>x</sub> always comes to the banquet with him. (Karttunen 1976)  
 [for each case / situation featuring a convention and a woman courted by Harvey at that convention: the woman in the situation under consideration comes to the banquet with Harvey]

**The proposal:** the distributivity contributed by habitual morphology is the same as the distributivity contributed by *always* in (25) – or covertly supplied in (24). We also need to slightly revise our semantics for maximal wh-indefinites: they do not introduce maximal sets of individuals, but **maximal sets of cases / situations** featuring individuals that satisfy their restrictor and nuclear scope.



**The universal / non-unique single-topic correlative:** also analyzed as before, except that habitual morphology distributes over the set  $G$  of sequences introduced in the topic clause, as desired.

28.  $jo^x$  laRkii lambii ho-tii hai,  
 which girl tall be-hab.f be.prs,

$vo_x$  khaRii **ho-tii** hai.  
 that one standing be-hab.f be.prs

$\max^x(\text{girl}(x) \wedge \text{tall}(x)) \wedge \text{dist}(\text{singleton}(x) \wedge \text{standing}(x))$

$G$	$x$
$g_1$	$girl_1$
$g_2$	$girl_2$
$g_3$	$girl_3$

**dist** breaks the input set of sequences into singleton subsets  
 then, everything in the scope of **dist** is evaluated relative to each singleton subset

$G_1$	$x$
$g_1$	$girl_1$

check that  $x$  is a singleton relative to  $G_1$  (necessarily true) and that  $x$  is standing

$G_2$	$x$
$g_2$	$girl_2$

check that  $x$  is a singleton relative to  $G_2$  (necessarily true) and that  $x$  is standing

$G_3$	$x$
$g_3$	$girl_3$

check that  $x$  is a singleton relative to  $G_3$  (necessarily true) and that  $x$  is standing

That is:

- i. the topic clause is interpreted as before
- ii. the comment clause receives a different interpretation due to the distributivity operator **dist** contributed by habitual morphology – the **dist** operator breaks the input set of sequences  $G = \{g_1, g_2, g_3\}$  into the singleton subsets  $G_1 = \{g_1\}$ ,  $G_2 = \{g_2\}$  and  $G_3 = \{g_3\}$  and requires the formula in its scope, i.e. the remainder of the comment clause, to be evaluated relative to each such singleton subset.

So, **dist** ensures the vacuous satisfaction / neutralization of the condition **singleton**( $x$ ): given that each set of sequences delivered by **dist** is a singleton, the set will store only one value for  $x$ . Hence, the  $\max^x$  operator contributed by the wh-indefinite yields the desired universal / non-unique interpretation.

**Summary of the proposal** – uniqueness effects in correlatives emerge as a result of the interaction of three distinct components:

- i. the **maximality over cases / situations** contributed by wh-indefinites, which update the context by introducing all the individuals that satisfy both their restrictor and their nuclear scope
- ii. the **singleton** requirement contributed by singular anaphors; this requirement applies to the set of cases / situations relative to which the anaphor is interpreted
- iii. the **granularity level** of the entire quantificational structure that the correlative denotes; the granularity is specified in Hindi by the presence vs. absence of habitual morphology:
  - the quantification can be **coarse-grained / episodic**, i.e. we 'collectively' quantify over the topical cases / situations introduced in the topic clause, which boils down to quantifying over topical individuals – and the comment clause is predicated of these individuals; this yields the definite / unique interpretation
  - the quantification can be **fine-grained / habitual**, i.e. we 'distributively' quantify over the topical cases / situations introduced in the topic clause – and the comment clause is predicated of each case / situation; this yields the universal / non-unique interpretation

## Correlatives in Romanian: cross-linguistic variation and the pragmatics of quantification

Romanian does not have habitual morphology. So, both unique and non-unique readings are available for single-topic correlatives – see (6) and (7).

In contrast: habitual morphology is *available* in Hindi to express non-unique readings, so it *has to be used* to express such readings.

This is an optimality-theoretic kind of reasoning: if a better candidate is *available* in a particular linguistic system – in our case, a candidate that pairs morphology and meaning more 'transparently' –, then this candidate *is* the grammatical one (unless there's an even better candidate). See Farkas & de Swart (2003) for a related proposal with respect to noun incorporation.

**The proposal:** the availability of habitual morphology in Hindi forces single-topic correlatives without habitual morphology to have a definite / unique reading. In Romanian, both readings can be associated with the same morpho-syntactic structure because no such morphology is available.

This is NOT to say that Romanian has covert habitual morphology of the kind overtly exhibited by Hindi – and that this morphology is covertly present whenever we have a universal reading.

Such a hypothesis would be as implausible as the idea that English has covert morphology distinguishing between the inclusive and the exclusive (i.e. +/- addressee) 1<sup>st</sup> person pronoun *we* of the sort exhibited by a variety of languages (e.g. Kalihna, Chinook or Boumaa Fijian; see Harley & Ritter 2002).

The 1<sup>st</sup> person singular pronoun *we* in English can have an inclusive or an exclusive **use**, i.e. this aspect of the interpretation of indexicals is part of pragmatics (and its interface with semantics).

Similarly, which reading is available for a particular correlative in Romanian depends on pragmatic factors, e.g. the accidental / sporadic vs. non-accidental / habitual nature of the situations under consideration.

**The proposal:** the semantics of correlative (in general: quantificational) structures crucially involves a *granularity* level, i.e. a specification of the way in which the comment clause (in general: the nuclear scope) is predicated of the cases / situations characterized by the topic clause (in general: the restrictor).

The granularity level of the quantification is specified only pragmatically, as in Romanian, or there can be grammatical / semantic means to constrain its specification, as in Hindi. This situation is similar to the cross-linguistic variation with respect to the inclusive vs. exclusive specification for 1<sup>st</sup> person pronouns.

Independent evidence for the idea that the semantics of quantification involves a granularity level that is only pragmatically specified comes from English examples like:

29. Four thousand ships passed through the lock last year.

(Krifka 1990)

The sentence "has two readings. [...] the **object-related** reading says that there are four thousand ships which passed through the lock last year. [...] the **event-related** reading says that there were four thousand events of passing through the lock by a ship last year. The object related reading presupposes the existence of (at least) four thousand ships [...]. In the event-related reading, there might be fewer ships in the world." (Krifka 1990)

The variation in ship individuation / counting is parallel to the way we interpret the **singleton** requirement in definite, i.e. 'object-related', correlatives vs. universal, i.e. 'event/situation-related', correlatives.

Moreover, just as the granularity level for Romanian correlatives is dependent on pragmatic factors, the selection of a granularity level for examples like (29) is pragmatically constrained:

"It is no accident that the best examples of [event-related readings] concern situations in which there are too many individuals to keep track of easily [...]. It is much more difficult to get [an event-related] reading of [(29)] when only a small number of ships are involved. [For example, consider] the Chicago River–Lake Michigan sightseeing route, which we can assume is plied by just four sightseeing ships. It would be odd to say that *Four thousand sightseeing ships passed through the lock last year* even if each of the four ships did go through 1,000 times." (Barker 1999)

This sensitivity to pragmatic factors (world knowledge) is left unexplained if we postulate two covertly different denotations – an object-related and an event-related one – for the cardinal indefinite *four thousand* (as Barker 1999 observes).

Similarly, the fact that the choice between a definite and a universal reading for Romanian correlatives is sensitive to pragmatic factors would be left unexplained if we postulated to existence of covert habitual morphology in Romanian.

### **What about multiple-topic correlatives?**

Analyzing single-topic correlatives in terms of maximal sets of cases / situations and not maximal sets of individuals is independently motivated by the interpretation of multiple-topic correlatives.

In multiple-topic correlatives, we have anaphora both to sets of individuals and to the *dependency* between them introduced in the topic clause. The Hindi correlative in (8) introduces a set of girls and, for each girl, the boy she played against. Then, the comment clause is about the "play against" relation between the two sets of girls and boys. Each girl defeated the boy she played against and not some other boy that some other girl played against. The "defeat" relation elaborates on the "play against" relation.

This is parallel to example (25): the "come to banquet" relation in the second sentence elaborates on the previously introduced "court at" relation between women and conventions – and not only on the 'unstructured', 'bare' sets of women and conventions.

If we have only maximal sets of individuals and distribute over such sets, there is no guarantee that the comment clause preserves and elaborates on the previously introduced relation between these sets. But if the topic clause introduces a maximal set of cases / situations, they encode the sets of individuals *and* the dependencies between them, so the comment clause can elaborate on both.

## 4 Extensions: Correlatives in the Degree Domain

Partee (1973, 1984) initiates the investigation of referential and quantificational parallels between the individual and temporal domains. This investigation is further extended to the modal domain by Stone (1997, 1999), Bittner (2001), Schlenker (2006) and Brasoveanu (2007) among others.

The overarching goal is to determine to what extent our semantic competence is domain neutral.

Extending this research program to the degree domain has received comparatively little attention in the literature – and the parallels between individual-based and degree/measure-based correlatives seem to be a good starting point, as indicated by the following Romanian comparative correlatives.

30. Cu cât e mai înalt fratele decât sora, cu atât e mai înalt tatăl decât mama.  
With how much is more tall brother.the than sister.the, 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.*
31. Cu cât e un avocat mai agresiv, cu atât 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 he is.*

The referential comparative correlative in (30) is parallel to the correlative in (6) above, which receives a definite / unique interpretation.

The quantificational (a.k.a. conditional) comparative correlative in (31) is parallel to the correlatives in (7) and (9) above, which receive a universal / non-unique interpretation.

## 5 Conclusion

What does all this tell us about the nature of reference and quantification in natural language?

The interpretation of correlatives adds further support to the idea that the distinction between referential and quantificational expressions in natural language is gradient, unlike the corresponding distinction in classical (first-order) logic.

This, in turn, indicates that frameworks in which we can 'decompose' quantification and analyze it as a structured notion involving both (i) *referential components*, i.e. variables / discourse referents that are introduced and anaphorically retrieved, and (ii) *non-referential components*, i.e. the maximization and distributivity operators used above, are better suited for the study of natural language interpretation.

## Appendix: Plural Compositional DRT (PCDRT)

### Dynamic Ty2.

Just as in Compositional DRT (CDRT; Muskens 1996), the underlying logic is Ty2 (Gallin 1975). There are three basic types: type  $t$  (truth-values); type  $e$  (individuals); type  $s$  (modeling DPL-style variable assignments).

Constants of type  $e$ : *linus*, *maureen* etc. Variables of type  $e$ :  $x$ ,  $x'$  etc. Variables of type  $s$ :  $i$ ,  $j$  etc.

A discourse referent (dref)  $u$  for individuals is a function of type  $se$  from assignments  $i_s$  to individuals  $x_e$  (subscripts on terms indicate their type). Intuitively, the  $u_{se}i_s$  is the individual that the assignment  $i$  assigns to the dref  $u$ .

Dynamic info states  $I$ ,  $J$  etc. are plural: they are sets of variable assignments (as in van den Berg 1996), i.e. they are terms of type  $st$ .

An individual dref  $u$  stores a set of individuals with respect to a plural info state  $I$ , abbreviated as  $uI := \{u_{se}i_s : i_s \in I_{st}\}$ , i.e.  $uI$  is the image of the set of assignments  $I$  under the function  $u$ .

Thus, drefs are modeled like individual concepts in Montague semantics: just as an individual concept is a function from indices of evaluation to individuals, a dref is a discourse-relative individual concept, i.e. a function from discourse salience states to individuals (we model a discourse salience state as a total variable assignment).

### Discourse Representation Structures.

A sentence is interpreted as a Discourse Representation Structure (DRS), i.e. as a relation of type  $(st)((st)t)$  between an input info state  $I_{st}$  and an output info state  $J_{st}$ :  $J$  differs from the input info state  $I$  at most with respect to the **new drefs** and  $J$  satisfies all the **conditions**:

**[new drefs | conditions]** :=  $\lambda I_{st}. \lambda J_{st}. I[\text{new drefs}]J \wedge \text{conditions}J$

E.g.:  $[u, u' | \text{girl}\{u\}, \text{boy}\{u'\}, \text{like}\{u, u'\}] := \lambda I_{st}. \lambda J_{st}. I[u, u']J \wedge \text{girl}\{u\}J \wedge \text{boy}\{u'\}J \wedge \text{like}\{u, u'\}J$

Tests -- DRSs that do not introduce new drefs:

**[conditions]** :=  $\lambda I_{st}. \lambda J_{st}. I=J \wedge \text{conditions}J$

E.g.:  $[\text{like}\{u, u'\}] := \lambda I_{st}. \lambda J_{st}. I=J \wedge \text{like}\{u, u'\}J$ .

### Conditions.

Conditions, e.g. lexical relations like  $\text{like}\{u, u'\}$ , are sets of plural info states, i.e. they are terms of type  $(st)t$ .

Lexical relations are *unselectively distributive* with respect to the plural info states they accept – they universally quantify over variable assignments:

$R\{u_1, \dots, u_n\} := \lambda I_{st}. I \neq \emptyset \wedge \forall i_s \in I (R(u_1i, \dots, u_ni))$ ,

for any non-logical constant  $R$  of type  $e^n t$ , where  $e^n t$  is defined as the smallest set of types such that:  
(i)  $e^0 t := t$  and (ii)  $e^{m+1} t := e(e^m t)$ .

E.g.:  $\text{like}\{u_1, u_2\} := \lambda I_{st}. I \neq \emptyset \wedge \forall i_s \in I (\text{like}(u_1i, u_2i))$ .

### Truth.

A DRS  $D$  of type  $(st)((st)t)$  is *true* with respect to an input info state  $I_{st}$  iff  $\exists J_{st}(DIJ)$ .

### Compositionality.

Given the underlying type logic, compositionality at sub-clausal level follows automatically since, in a Fregean / Montagovian framework, the compositional aspect of interpretation is largely determined by the types for the 'saturated' expressions, i.e. names and sentences. We abbreviate them as **e** and **t**.

An extensional static logic is the simplest: **e** is  $e$  (individuals) and **t** is  $t$  (truth-values). The denotation of the noun *book* is of type **et**, i.e.  $et: book \rightsquigarrow \lambda x_e. book_{et}(x)$ .

We go dynamic by making the 'meta-types' **e** and **t** finer-grained: **e** will be the type of drefs for individuals, i.e.  $se$ , and **t** will be the type of DRSs, i.e.  $(st)((st)t)$ . The denotation of the noun *book* is still of type **et**:

$$book \rightsquigarrow \lambda v_e. [book\{v\}], \quad \text{i.e. } book \rightsquigarrow \lambda v_e. \lambda I_{st}. \lambda J_{st}. I=J \wedge book\{v\}J.$$

### Singular anaphors.

$$vo_u / aceea_u / acela_u / it_u \rightsquigarrow \lambda P_{et}. [\mathbf{singleton}\{u\}]; P(u)$$

$$\mathbf{singleton}\{u\} := \lambda I_{st}. I \neq \emptyset \wedge \forall i_s \in I \forall i'_s \in I (ui=ui')$$

$$D; D' := \lambda I_{st}. \lambda J_{st}. \exists H_{st}(DIH \wedge D'HJ), \quad \text{where } D \text{ and } D' \text{ are DRSs (type } \mathbf{t})$$

### Indefinites.

$$jo^u / care^u / a^u \rightsquigarrow \lambda P_{et}. \lambda P'_{et}. \mathbf{max}^u(\mathbf{dist}(P(u); P'(u))) \quad (\text{they introduce maximal sets})$$

$$\mathbf{max}^u(D) := \lambda I_{st}. \lambda J_{st}. ([u]; D)IJ \wedge \forall K_{st}([u]; D)IK \rightarrow uK \subseteq uJ, \quad \text{where } D \text{ is a DRS (type } \mathbf{t}).$$

$$\mathbf{dist}(D) := \lambda I_{st}. \lambda J_{st}. \exists R_{s((st)t)} \neq \emptyset (I = \mathbf{Dom}(R) \wedge J = \mathbf{Ran}(R) \wedge \forall \langle k_s, L_{st} \rangle \in R (D\{k\}L))$$

$$\text{where } \mathbf{Dom}(R) := \{k_s: \exists L_{st}(RkL)\} \text{ and } \mathbf{Ran}(R) := \{L_{st}: \exists k_s(RkL)\}.$$

### Habitual morphology.

$$hotii \rightsquigarrow \lambda D_t. \mathbf{dist}(D)$$

Alternatively, we can have a VP modifier-like denotation:  $hotii \rightsquigarrow \lambda P_{et}. \lambda v_e. \mathbf{dist}(P(v))$ .

### Single-topic correlatives – definite / unique readings.

$$\text{TOPIC: } \mathbf{max}^u(\mathbf{dist}([girl\{u\}, tall\{u\}])); \text{ COMMENT: } [\mathbf{singleton}\{u\}]; [standing\{u\}]$$

### Single-topic correlatives – universal / non-unique readings.

$$\text{TOPIC: } \mathbf{max}^u(\mathbf{dist}([girl\{u\}, tall\{u\}])); \text{ COMMENT: } \mathbf{dist}([\mathbf{singleton}\{u\}]; [standing\{u\}])$$

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