Nominals are Doubly Dual

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1 Anaphora resolution

Since the so called integrative approach to anaphora resolution was set up in late eighties ([Carb88], [RL88], [AW89]) and its practical viability extensively checked up ([LL94], [Mit98], among others), it is common wisdom that factors determining the antecedents of anaphors divide into filters and preferences. The latter help to pick the most likely candidate, that will be proposed as the antecedent; the first exclude impossible antecedents and help to circumscribe the set of antecedent candidates

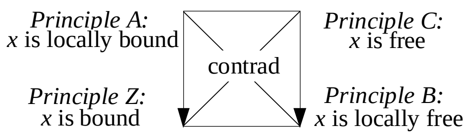
Binding constraints are a significant subset of such filters. They capture empirical generalizations concerning the relative positioning of anaphors with respect to their antecedents in the grammatical geometry of sentences. We follow here the definition proposed in [PS94] for these constraints, and subsequent extension in [XPS94], [BM99]:

> **Principle A:** A locally o-commanded short-distance reflexive must be locally o-bound.
> *Lee$_i$ thinks [Max$_j$ saw himself$_{*i/j}$].*
> **Principle Z:** An o-commanded long-distance reflexive must be o-bound.
> *Zhangsan$_i$ cong Lisi$_j$ chu tingshuo [Wangwu$_k$ bu xihuan ziji$_{i/*j/k}$].* [10]:ex(2)
> Zhangsan$_i$ heard from Lisi$_j$ [Wangwu$_k$ doesn't like "himself"$_{i/*j/k}$].
> **Principle B:** A pronoun must be locally o-free.
> *Lee$_i$ thinks [Max$_j$ saw him$_{i/*j}$].*
> **Principle C:** A non-pronoun must be o-free.
> *[Kim$_i$'s friend]$_j$ thinks [Lee saw Kim$_{i/*j}$].*

X *o-binds* Y iff X o-commands Y and X is the antecedent of Y. *O-commands* is a partial order under which, in a clause, the Subject o-commands the Direct Object, the Direct Object o-commands the Indirect Object, and so on, following the obliqueness hierarchy of grammatical functions; in multiclausal sentences, the upward arguments o-command the embedded arguments, etc. The *local domain* is, roughly, the subcategorization domain of the predicator selecting the anaphor.

When stripped away from procedural phrasing and non-exemption requirements, these generalizations, quite surprisingly, instantiate the following square of oppositions (detailed discussion in [BM99]):

(*)

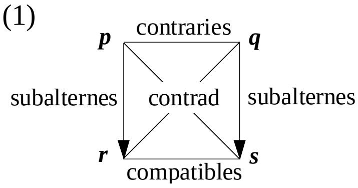


Given this square, the questions to pursue and the answers we argue for in this presentation are: (A) *Question*: Is this a sign that binding constraints are the effect of some underlying quantificational structure? *Answer*: Yes. (B) *Question*: What are the implications for our understanding of the semantics of nominals, and in particular of their dual nature as referential and quantificational expressions? *Answer*: Nominals are doubly dual, in a sense to made made precise in this presentation.

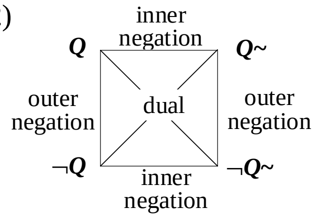
2 Phase quantification

Löbner suggested that the emergence of a square of logical duality between the semantic values of natural language expressions is a major empirical touchstone to ascertain their quantificational nature [Löb87]; and van Benthem, while noting that the ubiquity of the square of duality may be the sign of a semantic invariant possibly rooted in some cognitive universal, highlighted its heuristic value for research on quantification inasmuch as "it suggests a systematic point of view from which to search for comparative facts" [vanBent91](p.23).
Given the issues raised by (*), it is of note that the square of duality in (2) is different from the classical square of oppositions in (1): The difference lies in the fact that *duality*, *inner negation* and *outer negation* are third order concepts, while *compatibility*, *contrariness* and *implication* are second order concepts.

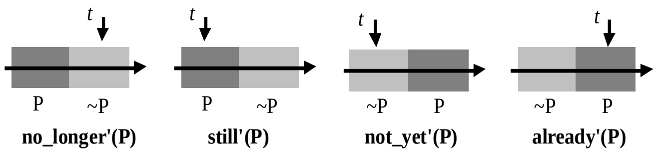
(1)



(2)



There are instantiations of the square of oppositions without corresponding squares of duality, and vice-versa ([Löb87],p.56 for discussion). Although the two squares are logically independent, the empirical emergence of a square of oppositions, such as the one in (*), naturally raises the question about the possible existence of an associated square of duality. We will argue that the answer to this question is affirmative and that it provides also an answer to question (A) above.
Before this result may be worked out, some analytical tools are to be introduced first. We will resort to the notion of phase quantification, which was introduced in [Löb87] to study the semantics of aspectual adverbials and was shown there to be extended to characterize quantification in general. For the sake of concreteness, consider a diagrammatic display of the semantics of these adverbials:



Very briefly, phase quantification requires the following ingredients: (i) a partial order over the domain of quantification; (ii) a property *P* defining a positive phase in a sequence of two opposite phases; (iii) a parameter point *t*; and (iv) the starting point of the relevant semiphase given the presupposition about the linear order between *P* and ~*P* phases.

For aspectual adverbials, (i) the order is the time axis; (ii) *P* denotes the instants where the proposition containing the adverbial holds; (iii) *t* is the reference time of the utterance; (iv) the starting point *s(R,t)* is the infimum of the set of the closest predecessors of *t* which form an uninterrupted sequence in *R* — the adverbials *no longer* and *still* bear the presupposition that phase *P* precedes phase *~P* (*~P.P* for the other two adverbials). These adverbials express the following quantifiers:

(3) **still'**: λP.every'(λx.(S(P,t)<x≤t),P) — dual — **not_yet'**: λP.no'(λx.(S(~P,t)<x≤t),P)

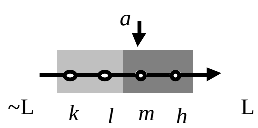
no_longer': λP.not_every'(λx.(S(P,t)<x≤t),P) — **already'**: λP.some'(λx.(S(~P,t)<x≤t),P)

3 Binding constraints

Turning to the quantificational structure of binding constraints, given the space constraints of this abstract, we take Principle A as a working example.

Phase quantification here is assumed to unfold over entities in grammatical representations, vz. reference markers *a la* DRT, and its ingredients are as follows: (i) Reference markers are ordered according to the o-command relation; (ii) *P* is here *L*, the set of markers in the local domain of the anaphor; (iii) *t* is instantiated as *a*, the marker of the antecedent for the anaphor.

The quantifier expressed by short-distance reflexives, ruled by Principle A, can be associated with the presupposition that *~L.L*. It receives the following definition, which is easily interpreted against the diagram corresponding to the example sentence, *Kim said Lee thinks Max$_i$ hit himself$_i$*, where *k*, *l*, *m* and *h* are the markers of *Kim*, *Lee*, *Max* and *himself*.



$\mathbf{Q_A}$:
λL.some'(λx.(s(~L,a)<x≤a,L)

Q_A(L) is satisfied iff between the bottom of the uninterrupted sequence *~L* most close to the antecedent *a* and *a* inclusive, there is at least one reference marker in *L*. As *~L* precedes *L*, this amounts to requiring that *a* be in *L*, the local domain of *h*, and consequently that *a* be a local o-commander of *h*, which matches precisely the requirement in Principle A.

In the presentation, we argue at length that this quantifier is one of the corners of a square of duality which includes quantifiers for the other three classes of anaphors. Such quantifiers result from those in (3) above simply by replacing *t* by *a*, and apply to *L* instead of *P*.

every'(R), still', $\mathbf{Q_Z}$,... — dual — no'(R), not_yet', $\mathbf{Q_B}$...

not_every'(R), no_longer', $\mathbf{Q_C}$,... — some'(R), already', $\mathbf{Q_A}$...

Just another very brief example. The phase quantifier of pronouns lies at the same corner as the quantifiers *no'* or *not_yet'*: *Q_B(L)* is satisfied when no reference marker between the beginning of *~L* and the antecedent *a* inclusive is in *L*, which implies that *a* has to be in *~L*, i.e. it has to be outside the local domain of the pronoun, as required in Principle B.

These results may shed new light over a number of interesting issues. For instance, given their parameterized validity across natural languages, the universal character of binding principles has been seen as a striking feature: When envisaged as a set (the so-called "binding theory"), they appear as one of the best candidates to be a module of universal grammar. Given the universality of quantification in natural language, if binding constraints are the visible effect of quantifiers, it is not surprising then they are universally operative across natural languages.

Besides, not all languages have anaphors of each of the four binding types. In English, there is no long-distance reflexives. This is in line with the well known fact that not every corner of a duality square may be "lexicalized", as Löbner puts it: In some squares, there may not exist a single expression for a given corner, which is then expressed by some other means (e.g. a complex expression, such as *not every* — [Löb87],p.65 for a fully-fledged discussion).

5 The duality reference vs. quantification

Many authors have underlined that there is no correspondence between surface and logical form of quantificational expressions of natural languages. Löbner emphasized this non-correspondence by pointed out that, while domain restrictor and quantified predicate are rendered by two different surface expressions in nominal quantification, in phase quantification expressed by aspectual adverbials, only the quantified predicate is available at the surface form.

With phase quantification expressed by anaphors, this gulf between surface and logical form widened further: There is no surface expression directly rendering either the domain restrictor of quantification or the quantified predicate.

More important, quantification is extended to universes whose elements are not entities of the "extra-grammatical" universe, but entities of the "intra-grammatical" world itself: The models against which binding phase quantification is to be interpreted are not representations of the world, with everyday entities like donkeys, farmers, etc., but grammatical representations, with entities like reference markers, grammatical functions, etc. Hence, satisfaction of a formula made out of a binding phase quantifier, $Q_{\boldsymbol{A}}$, $Q_{\boldsymbol{Z}}$, $Q_{\boldsymbol{B}}$ and $Q_{\boldsymbol{C}}$, turns out to be a well-formedness constraint on the sentence where the corresponding anaphor occurs: For the meaning of "classic" quantification to be determined, one has to know how the world has to be for it to be true; for the meaning of binding phase quantification to be determined, one has to know how the corresponding grammatical representation has to be for it to be true.

Finally, it is worth considering the implications of the results above for the overall semantic make up of nominals. The shared wisdom is that nominals convey either quantificational or referential force — a large bulk of the research on the semantics of nominals has been concerned with determining which side of this divide definite descriptions belongs to ([Neale93], [LS95] a.o.). For the sake of the argument, let us accept that definites are referential terms. Let us also take into account that proper names are ruled by binding Principle C.

Given these assumptions, the analysis presented above imply that nominals with "primary" referential force (*he*, *the book*, *John*,...) have a certain "secondary" quantificational force: They express quantificational requirements — over reference markers in grammatical representations

—, but cannot be used to directly quantify over extra-linguistic world entities, like the other "primarily" quantificational nominals do (*every man*, *most students*,...).
This duality of semantic behavior, however, turns out not to be that much surprising if one observes a symmetric duality with regards to quantificational nominals, apparent when they act as antecedents in e-type anaphora, as in the example *Most students$_i$ came to the party and they$_i$ had a wonderful time*. The analysis of e-type anaphora envisaged by some authors (e.g. [KR93]:4.1.2) implies that nominals with "primary" quantificational force have a certain "secondary" referential force: These nominals have enough referential strength to evoke and introduce reference markers in the grammatical representation that can be picked as antecedents by anaphors — and thus support the referential force of the latter —, but they cannot be used to directly refer to extra-linguistic entities, like the other "primarily" referential terms do.
If the results reported here are meaningful, the duality quantificational vs. referential nominals is less strict but more articulated than it has been assumed. Possibly taking indefinite descriptions aside, every nominal makes a contribution in both semantic dimensions of quantification and reference, but with respect to different universes. "Primarily" referential nominals have a dual semantic nature — they are "primarily" referential and "secondarily" quantificational — that is symmetric of the semantic nature of "primarily" quantificational ones — they are "primarily" quantificational and "secondarily" referential.
Besides the fact that when expressing quantificational force, many nominals are logical duals of other nominals, when it comes to the duality reference vs. quantification, nominals seem to have a doubly dual semantic nature, where reference and quantification are much more intertwined than what had been figured out.

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