

Duality and Anaphora

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Abstract *The four constraints on sentential anaphoric binding, known as binding principles, are observed to form a square of oppositions. With the formal tools of phase quantification, these constraints are analysed as the effect of phase quantifiers over reference markers in grammatical obliqueness hierarchies. The four quantifiers are shown to be organized in a square of duality. The impact of this result on the distinction quantificational vs. non quantificational NPs and on the semantics of nominals in general is discussed.*

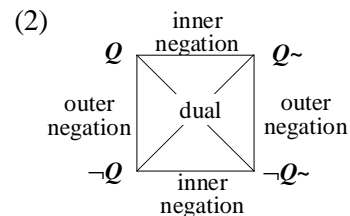
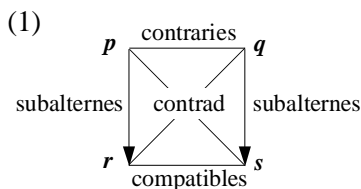
1 Quantification and Duality

Logical duality has been a key issue in natural language semantics. It is a pattern noticed in many phenomena, ranging from the realm of determiners to the realm of temporality and modality, including topics such as the adverbials *still/already* or the conjunctions *because/although*, etc. ([6], [7], [5], [9] *i.a.*).

While noting that the ubiquity of the square of duality may be the sign of a semantic universal, [1],p.23 highlighted its heuristic value for research on quantification inasmuch as "it suggests a systematic point of view from which to search for comparative facts"—a hint we explore in this paper.

2 Anaphoric Binding Constraints

Given our purpose here, 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. There are instantiations of the square of oppositions without corresponding squares of duality, and vice-versa ([6],p.56 for discussion).

Although the two squares are logically independent, the empirical emergence of a square of oppositions naturally raises the question about the possible existence of an associated square of duality. This is where we get focussed into our research topic, given the emergence of a square of oppositions with the four constraints on sentential anaphoric binding, also

known as binding principles.

Binding constraints 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 [8] for these constraints, and subsequent extension in [10], [2]:

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.

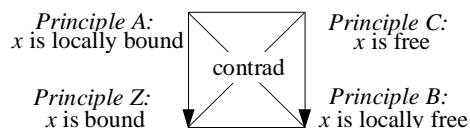
*Lee_i thinks [Max_j saw him_{i/*j}].*

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. [8],p.279. The *local domain* is, roughly, the subcategorization domain of the predicator selecting the anaphor (details in [3]).

When stripped away from procedural phrasing and non-exemption requirements, these generalizations instantiate the following square of oppositions ([2] for detailed discussion):

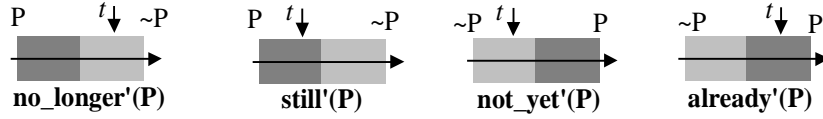


Given this square, the question to pursue is whether this is a sign that binding principles are the effect of some underlying quantificational structure, i.e. whether there is a square of duality associated with the constraints on anaphoric binding.

3 Phase Quantification

We argue that the answer to this question is affirmative. Before this result may be worked out, some analytical tools are to be introduced first.

We resort to the notion of phase quantification, introduced in [6] to study the semantics of aspectual adverbials and shown to be extended to characterize quantification in general [6],p.74. For the sake of concreteness, consider a diagrammatic display of the semantics of such adverbials:



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

For aspectual adverbials, (i) the order is the time axis; (ii) t is the reference time of the utterance; (iii) P denotes the instants where the proposition containing the adverbial holds; (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 — e.g. the adverbials *no longer* and *still* bear the presupposition that phase P precedes $\sim P$. These adverbials express the following quantifiers:

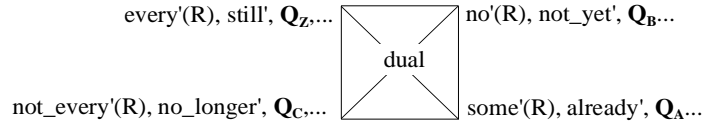
(3) still' : $\lambda P.\text{every}'(\lambda x.(S(P,t)<x\leq t),P)$	dual	not_yet' : $\lambda P.\text{no}'(\lambda x.(S(\sim P,t)<x\leq t),P)$
no_longer' : $\lambda P.\text{not_every}'(\lambda x.(S(P,t)<x\leq t),P)$		already' : $\lambda P.\text{some}'(\lambda x.(S(\sim P,t)<x\leq t),P)$

4 Quantificational Anaphors

With this in place, the empirical generalizations captured in the binding principles can be argued to be the visible effect of the phase quantificational nature of the corresponding nominals: Below, anaphors are shown to express one of four quantifiers acting on the grammatical obliqueness order.

Phase quantification here is assumed to unfold over entities in grammatical representations, *vz.* reference markers [4], and its ingredients are as follows: (i) *Order*: reference markers are ordered according to the o-command relation; (ii) *Parameter point*: t is a here, the marker of the antecedent for the anaphoric nominal at stake; (iii) *Phase property*: P is D here, which denotes the set of markers in the grammatical domain of the anaphor: For a nominal anaphor N , D is determined by the relative position of N in the obliqueness order which N enters. Given m , the reference marker of N , semiphase D_m is a stretch containing m and elements that are less than m in the obliqueness order, i.e. markers of o-commanders of N ; if semiphase D_m is presupposed to precede $\sim D_m$, D_m is such that the last successor in it is local wrt to m ; and if $\sim D_m$ precedes D_m , the first predecessor in D_m is local wrt to m , however locality for binding may be parameterised in each language [3]. In both cases the closest D_m neighbour of semiphase $\sim D_m$ is local wrt m : $D_m(x)$ iff $x\leq r \wedge \forall y[(\sim D_m(y) \wedge (x<y \vee y<x)) \rightarrow (x \text{ is local wrt } m \wedge y \text{ is not local wrt } m)]$

With this replacements in (3), one gets four phase quantifiers — we termed Q_Z , Q_B , Q_C and Q_A — entering the square of duality and aligning with other quantifiers of similar quantificational force at each of the corners:



These four phase quantifiers ensure the same empirical predictions as secured by the four binding principles, as we can briefly check out below.

A: The quantifier expressed by short-distance reflexives is associated with the presupposition that $\sim D.D$. 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* — k, l, m and h are resp. the markers of *Kim, Lee, Max* and *himself*, and x_1, \dots, x_n are markers not in the obliqueness relation of h , possibly introduced in other sentences of the discourse or available in the context (Hasse diagrams displayed with a turn of 90° right):



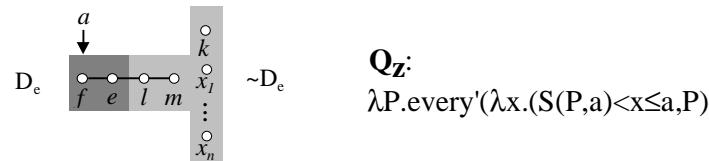
$Q_A(D_h)$ is satisfied iff between the bottom of the uninterrupted sequence $\sim D_h$ most close to the antecedent a and a inclusive, there is at least one reference marker in D_h . As $\sim D_h$ precedes D_h , this amounts to requiring that a be in D_h , the local domain of h here, and consequently that a be a local o-commander of h , which matches the requirement in Principle A. Binding phase quantifier Q_A shows positive existential force and short-distance reflexives align in the square of duality with items like *some N, already, possibly*, etc.

B: The phase quantifier expressed by pronouns, in turn, lies at the same corner as the quantifiers *no'(R)* or *not_yet'* in (3). The presupposition conveyed by these anaphors is also that $\sim D.D$, and Q_B is easily understood when considering the diagrammatic description of an example like *Kim said Lee_i thinks Max hit him_i*:



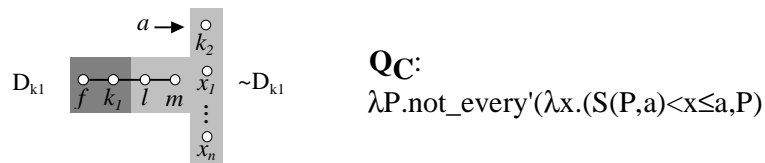
$Q_B(D)$ is satisfied iff no reference marker between the bottom of $\sim D$ and the antecedent a inclusive is in D , which implies that a has to be in $\sim D$, i.e. it has to be outside the local domain of the pronoun, as required in Principle B.

Z: Turning to long-distance reflexives, we consider an example from Portuguese (*[O amigo de Kim]_i disse que [ele próprio]_i acha que Lee viu Max.*) [*Kim's friend*]_i said "*ele próprio*"_i thinks *Lee saw Max*:



As with short-distance reflexives, a is here required to occur in D_e though the presupposition conveyed now is that semiphase D is followed by semiphase $\sim D$. Taking into account the definition of D_e above, the antecedent is required to be an o-commander (local or not) of e . The semantics of the phase quantifier \mathbf{Q}_Z is such that, for $Q_Z(D_e)$ to be satisfied, between the bottom of the uninterrupted sequence D_e closest to the antecedent a and a inclusive, every reference marker is in D_e . This amounts to requiring a to be in D_e , i.e. to requiring it to be an o-commander of e , as predicted by Principle Z.

C: While long-distance reflexives show positive universal force, the quantifier expressed by non-pronouns appears at the same corner as quantifiers like *not_every'(R)*, *no_longer'*, etc. Let us consider a first version of the diagram of *Kim(2)'s friend said Kim(1)_i thinks Lee saw Max*:

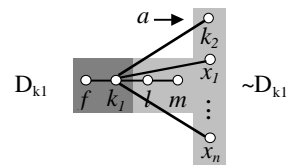


The antecedent a should be required to occur in $\sim D_{k_l}$, which means that a cannot be an o-commander of k_l : This renders the same constraint as expressed by principle C, that non-pronouns are free. As in previous diagrams, $\sim D$ is taken as the complement set of D . Correct empirical prediction requires this to be refined and a more accurate definition of $\sim D$ to be given for phase quantification in non-linear orders — as the one under consideration — where not all elements are comparable.

For $Q_C(D_{k_l})$ to be satisfied, between the bottom of D_{k_l} and the antecedent a inclusive, not every reference marker is in D_{k_l} . In examples as the one above, $\lambda x.(S(D_{k_l}, a) < x \leq a)$, the restrictor of \mathbf{Q}_C , is always empty: It is not the case that $S(D_{k_l}, a) \leq a$ because $a = k_2$ (or $a = x_i$ for any i) is not comparable to any element of D_{k_l} , including its bottom. Hence, $\text{not_every}'(\lambda x.(S(D_{k_l}, a) < x \leq a), D_{k_l})$ is false whatever reference marker k_2 or x_i is taken as the antecedent for k_l . The specific anaphor resolution in our example would be incorrectly ruled out.

This suggests that when phase quantification operates on non-linear orders, negation of semiphase P may be slightly more sophisticated than simple Boolean negation rendering its complement set. We are taught that negation of P also involves the lifting of the complement set,

\bar{P}_\perp , with \perp equal to the top of P when $P \sim P$ (k_l in our example). We can check that this specification of $\sim P$ makes it possible to satisfy $Q_C(D_{k_l})$ in the correct anaphoric links for non pronouns:¹



¹ For the sake of formal uniformity, when $\sim P.P$, the order-theoretic dual of this definition for $\sim P$ can also be assumed.

5 The Semantics of Nominals

These results may shed new light over a number of interesting issues. For instance, given their parameterised validity across natural languages [3], the universal character of binding principles has been seen as a striking feature: When envisaged as a set (so-called binding theory), they appear as one of the best candidates to be a module of universal grammar. Given the universality of quantification, if binding principles are the noticeable effect of quantifiers, it is not surprising that they are universally operative across natural languages.

Second, 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 "lexicalised", 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*, etc. — [6],p.65 for a fully-fledged discussion).

Finally, it is interesting to notice the inverted analogy between referential and quantificational NPs. Nominals with "genuine" quantificational force (*every man, most students,...*) have a somewhat "secondary" referential force, as revealed in e-type anaphora: Although they introduce markers in the grammatical representation that can be picked as antecedents by anaphors (vd. Σ -abstraction [4]Ch4), they cannot be used to refer to "outside world" entities.

Conversely, NPs with "genuine" referential force (*he, the book, John,...*), we can consider it now, have a somewhat "secondary" quantificational force: They introduce quantificational requirements over grammatical entities, but cannot be used to directly quantify over "outside world" entities.

If the results reported here are meaningful, and taking aside indefinites, every NP, quantificational or referential, has a dual nature by making a contribution in both dimensions of quantification and reference, but with respect to different universes.

References

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