ANAPHORIC BINDING AND PHASE QUANTIFICATION

António Horta Branco
Faculty of Sciences, University of Lisbon

1. Introduction

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.

2. 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. (LÖBNER, 1987, ter MEULEN, 1988, KÖNIG, 1991, SMESSAERT, 1997 i.a.).

While noting that the ubiquity of the square of duality may be the sign of a semantic universal, (van BENTHEM, 1991, 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.

Postal address: Departamento de Informática, Faculdade de Ciências de Lisboa, Campo Grande, 1700 Lisboa.
2 This communication was also presented at the Thirteenth Amsterdam Colloquium, University of Amsterdam, December 17-19, 2001.
3. 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).

\[
\begin{array}{c}
\text{contraries} \\
p \\
\text{subalterns} \\
q \\
\text{contrad} \\
\text{composites} \\
r \\
s \\
\text{subalterns}
\end{array}
\]

\[
\begin{array}{c}
\text{inner} \\
Q \\
\text{negation} \\
\sim Q \\
\text{outer} \\
negation \\
\sim Q^\sim \\
Q^\sim \\
\text{inner} \\
\text{negation} \\
\text{dual} \\
\text{negation}
\end{array}
\]

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 (see (LÖBNER, 1987, 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 (POLLARD and SAG, 1994) for these constraints, and subsequent extension in (XUE, POLLARD and SAG, 1994, BRANCO and MARRAFA, 1999):

**Principle A**: A locally 0-commanded short-distance reflexive must be locally 0-bound.

\[\text{Lee, thinks [Max; saw himself,_{ij}].}\]

**Principle Z**: An o-commanded long-distance reflexive must be o-bound.

\[\text{Zhangsan; cong Lisi; chu tingshuo [Wangwu,_{k} bu xibuan ziji,_{ij}].}\]
Zhangsan_{i} heard from Lisi_{j} [Wangwu_{k} doesn’t like “himself”]_{ii'ji'k}.
(cf. XUE, POLLARD and SAG, 1994, ex.(2))

**Principle B:** A pronoun must be locally o-free.

Lee_{i} thinks [Max_{i} saw him_{ii'+i}].

**Principle C:** A non-pronoun must be o-free.

[Kim_{i}'s friend_{i} thinks [Lee saw Kim_{ii'}]].

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. (POLLARD and SAG, 1994, p. 279). The local domain is, roughly, the subcategorization domain of the predicador selecting the anaphor (details in (DALRYMPLE, 1993)).

When stripped away from procedural phrasing and non-exemption requirements, these generalizations instantiate the following square of oppositions (see (BRANCO and MARRAFA, 1999) for a detailed discussion):

\[
\begin{array}{ccc}
\text{Principle A:} & \text{Principle B:} \\
x \text{is locally bound} & x \text{is free} \\
\text{contrad} & x \text{is locally free} \\
x \text{is bound} & \\
\end{array}
\]

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.

4. 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 (LÖBNER, 1987) to study the semantics of aspectual adverbials and shown to be extended to characterize quantification in general (LÖBNER, 1987, 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;
(iv) and the starting point of the relevant semiphase given the presupposition about the linear order between $P$ and $\neg P$.

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 $\neg P$.

These adverbials express the following quantifiers:

\begin{align*}
\text{still}' & : \lambda P. \text{every}'(\lambda x. (S(P, t) < x \leq t), P) \\
\text{not_yet}' & : \lambda P. \text{no}'(\lambda x. (S(\neg P, t) < x \leq t), P) \\
\text{no_longer}' & : \lambda P. \text{not every}'(\lambda x. (S(P, t) < x \leq t), P) \\
\text{already}' & : \lambda P. \text{some}'(\lambda x. (S(\neg P, t) < x \leq t), P)
\end{align*}

5. 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 (KAMP and REYLE, 1993), 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 \(N\), semphase \(D_m\) is a stretch containing \(m\) and elements that are less than \(m\) in the obliqueness order; i.e. markers of \(\omega\)-commanders of \(N\); if semphase \(D_m\) is presupposed to precede \(\sim D_m\), \(D_m\) is such that the last successor in it is local with respect to \(m\); and if \(\sim D_m\) precedes \(D_m\), the first predecessor in \(D_m\) is local with respect to \(m\), however locality for binding may be parameterised in each language (DALRYMPLE, 1993). In both cases the closest \(D_m\) neighbour of semphase \(\sim D_m\) is local with respect to \(m\) \(D_m(x)\) iff

\[
x \leq_{sr} \exists y ((\sim D_m(y) \ 
\forall (x < y \wedge x \leq x)) (x \text{ is local wrt } m \ 
\forall y \text{ is not local wrt } m))]
\]

With this replacements in (5), one gets four phase quantifiers – we termed QZ, QB, QC and QA – entering the square of duality and aligning with other quantifiers of similar quantificational force at each of the corners:

\[
\begin{array}{c}
\text{every}'(\text{R}), \text{still}' , Q_z, \ldots \quad \text{dual} \quad \text{no}'(\text{R}), \text{not}_y \text{et}' , Q_b, \ldots \\
\text{not}_{\text{every}}'(\text{R}), \text{no}_{\text{longer}}', Q_c, \ldots \quad \text{some}'(\text{R}), \text{already}', Q_a, \ldots \\
\end{array}
\]

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

5.1 **Principle 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 Maxi hit himself* – \(k, l, m\) and \(b\) are respectively the markers of *Kim, Lee, Max* and *himself*, and \(x_1, \ldots, x_n\) are markers not in the obliqueness relation of \(b\), possibly introduced in other sentences of the discourse or available in the context (Hasse diagrams displayed with a turn of 90° right):

\[
\begin{array}{c}
\sim D_b \\
\text{D}_b \\
\lambda P. \text{some}'(\lambda x. (S(\sim P a) < x \leq a)) \\
\end{array}
\]

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

5.2 Principle $B$  

The phase quantifier expressed by pronouns, in turn, lies at the same corner as the quantifiers $no'\langle R \rangle$ or not\_yet' in (5). The presupposition conveyed by these anaphors is also that $\sim D.D$, and $QB$ is easily understood when considering the diagrammatic description of an example like *Kim said Lee thinks Max hit him*:

$$\sim D_b$$  

\(QB\):

$$\lambda P.\, no'(\lambda x.(S(\sim P,a)<x\leq a,P))$$

$QB(D)$ 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 $B$.

5.3 Principle $Z$

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

$$\sim D_e$$  

\(QZ\):

$$\lambda P.\, every'(\lambda x.(S(P,a)<x\leq a,P))$$

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 $QZ$ is such that, for $QZ(D_e)$ 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.

5.4 Principle 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), thinks Lee saw Max*:

\[
\lambda P. \text{not_every'(} \lambda x. (S(P,a)<x\leq a,P) \text{)}
\]

The antecedent $a$ should be required to occur in $\neg D_{k_1}$, which means that $a$ cannot be an o-commander of $k_1$: This renders the same constraint as expressed by principle C, that non-pronouns are free. As in previous diagrams, $\neg D$ is taken as the complement set of $D$. Correct empirical prediction requires this to be refined and a more accurate definition of $\neg D$ to be given for phase quantification in non-linear orders – as the one under consideration – where not all elements are comparable.

For $Q_C(D_{k_1})$ to be satisfied, between the bottom of $D_{k_1}$ and the antecedent $a$ inclusive, not every reference marker is in $D_{k_1}$. In examples as the one above, $\lambda x. (S(D_{k_1},a)<x\leq a)$, the restrictor of $Q_C$, is always empty: It is not the case that $S(D_{k_1},a)\leq a$ because $a=k_2$ (or $a=x_i$ for any $i$) is not comparable to any element of $D_{k_1}$, including its bottom. Hence, $\text{not_every'(} \lambda x. (S(D_{k_1},a)<x\leq a), D_{k_1})$ is false whatever reference marker $k_2$ or $x_i$ is taken as the antecedent for $k_1$. 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, $P$ with equal to the top of $P$ when $P, \neg P$ (of $k_1$ in our example). We can check that this specification of $\neg P$ makes it possible to satisfy $Q_C(D_{k_1})$ in the correct anaphoric links for non pronouns:\textsuperscript{3}

\textsuperscript{3} For the sake of formal uniformity, when $\neg P P$, the order-theoretic dual of this definition for $\neg P$ can also be assumed.
6. Discussion and Conclusions

These results may shed new light over a number of interesting issues. For instance, given their parameterised validity across natural languages (DALRYMPLE, 1993), 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. – see (DALRYMPLE, 1993, 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. A-abstraction in (KAMP and REYLE, 1993, Cap. 4), 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 BIBLIOGRAPHIES

KÖNG, E., 1991 – “Concessive Relations as the Dual of Causal Relations”. In Zäfferrer, pp. 190-209.