Anaphoric Constraints and Dualities in the Semantics of Nominals

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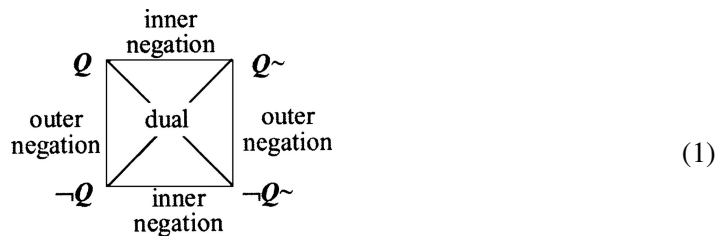*E-mail: Antonio.Branco@di.fc.ul.pt*

Abstract. The grammatical constraints on anaphoric binding, known as binding principles, are observed to form a classical square of oppositions. These constraints are then analysed as the effect of phase quantifiers over reference markers in grammatical obliqueness hierarchies, and the resulting phase quantifiers are shown to be organised in a square of logical duality. The impact of this result on the distinction between quantificational and referential nominals as well as on the logical foundations of the semantics of nominals in general is discussed.

Key words: Anaphora, binding principles, duality, natural language semantics, quantification

1. Introduction

Logical duality has been a key issue in the study of natural language and, in particular, in the study of quantification as this happens to be expressed in natural language. It is a pattern noticed in the semantics of many linguistic expressions and phenomena, ranging from the realm of determiners to the realm of temporality and modality, including topics such as the semantics of the adverbials *still*/*already* or of the conjunctions *because*/*although* etc.*

Under this pattern, one recurrently finds groups of syntactically related expressions whose formal semantics can be rendered as one of the operators arranged in a square of duality. Such a square is made of operators that are interdefinable by means of the relations of outer negation, inner negation, or duality (concomitant outer and inner negation):

$$
\begin{array}{ccc}
 & \text{inner negation} & \\
\boldsymbol{Q} & \!\boxed{}\! & \boldsymbol{Q}\!\sim \\
\text{outer negation} & \text{dual} & \text{outer negation} \\
\neg\boldsymbol{Q} & \text{inner negation} & \neg\boldsymbol{Q}\!\sim
\end{array}
\tag{1}
$$

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*Cf. (Löbner, 1987, 1989, 1999; ter Meulen, 1988; König, 1991; Smessaert, 1997).

The semantic values of the English expressions *every N, no N, some N* and *not every N*, or their translational equivalents in other natural languages, provide the classical example of an instantiation of the square above:
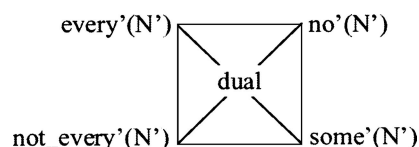
In this connection, Löbner (1987) suggested that the emergence of a notoriously non-trivial square of logical duality between the semantic values of natural language expressions is a major empirical touchstone to ascertain their quantificational nature; and van Benthem (1991), while noting that the ubiquity 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" (p. 23) — hints we will explore in the present paper.

Given our purpose here, it is of note that the square of duality in (1) is different and logically independent from the classical square of oppositions in (2):

(2)
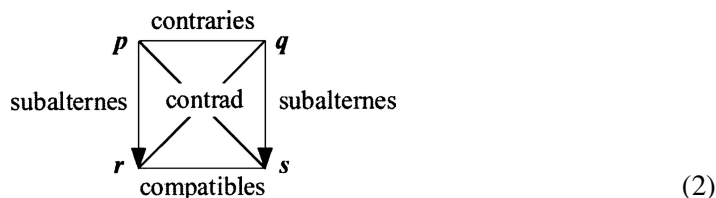
The difference lies in the fact that duality, inner negation and outer negation are third order concepts, while compatibility, contrariness and implication are second order concepts. As a consequence, it is possible to find instantiations of the square of oppositions without a corresponding square of duality, and vice-versa.*

Although the two squares are logically independent, the empirical emergence of a square of oppositions for the semantic values of natural language expressions naturally raises the question about the possible existence of an associated square of duality, and about the quantificational nature of these expressions. This is where we get focussed into the research issue of this paper given the emergence of a square of oppositions with the grammatical constraints on anaphoric binding, also known as binding principles.

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*Vd. (Löbner, 1987) for examples and discussion.

2. Anaphoric Binding Constraints

Binding principles capture generalisations concerning the constraints on the relative positioning of anaphors with respect to their admissible antecedents in the grammatical geometry of sentences.

From an empirical perspective, these constraints stem from what appears as quite cogent generalisations and exhibit a universal character, given the hypothesis of their parameterised validity across natural languages. From a conceptual point of view, in turn, the relations among the definitions of binding constraints involve non-trivial cross symmetry, which lends them a modular nature and provides further strength to the plausibility of their universal character. Binding principles, together with their auxiliary notions, have thus been considered one of the most significant modules of grammatical knowledge, usually termed as "binding theory" in generative linguistics.

2.1. CONSTRAINTS

We follow here the definition of binding constraints and the approach to binding theory proposed in (Pollard and Sag, 1994), and subsequent discussion and extension in (Xue et al., 1994; Branco, 1996, 2000, 2002a,b; Branco and Marrafa, 1997, 1999; Manning and Sag, 1999; Wechsler, 1999; Koenig, 1999; Richter et al., 1999; Golde, 1999; Kiss, 2001) which is presented below together with some examples, as a set of four constraints as originally proposed in (Xue et al., 1994).*

These constraints on the anaphoric capacity of nominals induce a partition of the set of anaphors into four classes. According to this partition, every nominal phrase anaphor is of one of the following anaphoric types: Short-distance reflexive, long-distance reflexive, pronoun, or nonpronoun.

(3)

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

> $\dots X_x \dots$ [Lee$_i$'s friend]$_j$ thinks [[Max$_k$'s neighbour]$_l$ likes
>
> himself$_{*x/*i/*j/*k/l}$].

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

> $\dots X_x \dots$[O amigo do   Lee$_i$]$_j$ acha   [que[o   vizinho
> $\dots X_x \dots$the friend of_the Lee   thinks that the neighbour
> do   Max$_k$]$_l$ gosta dele   próprio $_{*x/*i/j/*k/l}$]. (Portuguese)
> of_the Max   likes of_him self

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*For an overview on how grammatical binding constraints are accommodated in different grammatical frameworks, see (Everaert, 2000).

'$\ldots X_x \ldots$[Lee$_i$'s friend]$_j$ thinks [[Max$_k$'s neighbour]$_l$ likes him$_{*x/*i/j/*k}$/himself$_l$].'

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

$\ldots X_x \ldots$ [Lee$_i$'s friend]$_j$ thinks [[Max$_k$'s neighbour]$_l$ likes him$_{x/i/j/k/*l}$].

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

$\ldots X_x \ldots$ [Lee$_i$'s friend]$_j$ thinks [[Max$_k$'s neighbour]$_l$ likes the boy$_{x/i/*j/k/*l}$].

2.2. PARAMETERISATION

The empirical generalizations stated above are captured with the help of a few auxiliary notions. For many of these auxiliary notions, their final value or definition is amenable to be set according to a range of options. As briefly exemplified below, this parameterisation may be driven by the particular language at stake, by the relevant predicator selecting the anaphor, by the specific anaphor, etc.[*]

O-binding is such that x o-binds y iff x o-commands y and x and y are coindexed (*o-freeness* is non o-binding).

Coindexation is meant to represent an anaphoric link between the expressions with the same index ('$\ldots X_x \ldots$' represents a generic, extrasentential antecedent).

2.2.1. *Command*

O-command is a partial order defined on the basis of obliqueness hierarchies, possibly embedded in each other along the relation of subcategorisation: "Y o-commands Z just in case either Y is less oblique than Z; or Y o-commands some X that subcategorises for Z; or Y o-commands some X that is a projection of Z" (Pollard and Sag, 1994, p.279).[**] Accordingly, in a clause, the Subject o-commands the Direct Object, the Direct Object o-commands the Indirect Object, etc.; and in a multiclausal sentence, the arguments in the upwards clauses o-command the arguments in the successively embedded clauses.

In languages like English, the o-command order can be established over the obliqueness hierarchies of active and passive sentences alike:[***]

John$_i$ shaved himself$_i$.
John$_i$ was shaved by himself$_i$.

In some other languages, only the obliqueness hierarchy of the unmarked construction of a given syntactic alternation is available to support the o-command order

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[*]For an efficient verification procedure of the constraints in (3) in a unification-based setting, open to parameterisation, see (Branco, 2002a).

[**]For a discussion of the notion of obliqueness as well as further references on this topic, see (Pollard and Sag, 1987, Sec. 5.2).

[***]Cf. (Jackendoff, 1972) and (Pollard and Sag, 1994).

relevant for binding constraints both in the unmarked and the marked constructions of the alternation. This is the case, for example, of the alternation active/objective voice in Toba Batak. In this language, a reflexive in Object position of an active voice sentence can have the Subject as its antecedent, but not vice-versa:*

mang-ida diri-na$_i$ si John$_i$. (Toba Batak)
[ACTIVE-saw himself$_{\text{Object}}$]$_{VP}$ PM John$_{\text{Subject}}$
'John$_i$ saw himself$_i$.'
mang-ida si John$_i$ diri-na$_{*i}$.
[ACTIVE-saw PM John$_{\text{Object}}$]$_{VP}$ himself$_{\text{Subject}}$

Taking the objective voice paraphrase corresponding to the active sentence above, the binding pattern is inverted: A reflexive in Subject position can have the Object as its antecedent, but not vice-versa, thus revealing that the obliqueness hierarchy relevant for the verification of its binding constraint remains the hierarchy of the corresponding active voice sentence above:

di-ida diri-na$_{*i}$ si John$_i$.
[OBJECTIVE-saw himself$_{\text{Object}}$]$_{VP}$ PM John$_{\text{Subject}}$
di-ida si John$_i$ diri-na$_i$.
[OBJECTIVE-saw PM John$_{\text{Object}}$]$_{VP}$ himself$_{\text{Subject}}$
'John$_i$ saw himself$_i$.'

2.2.2. *Subject-Orientedness*
O-command may take the shape of a linear or a non linear order depending on the specific obliqueness hierarchy upon which it is realised.

In a language like English, the arguments in the subcategorisation frame of a predicator are typically arranged in a linear obliqueness hierarchy.

In some other languages, the obliqueness hierarchy upon which the o-command order is based may happen to be non linear: In the subcategorisation frame of a predicator, the Subject is less oblique than any other argument while the remaining arguments are not comparable to each other under the obliqueness relation. As a consequence, in a clause, a short-distance reflexive with an Indirect Object grammatical function, for instance, may only have the Subject as its antecedent, its only local o-commander.**

This Subject-orientedness effect induced on the anaphoric capacity of reflexives by the non linearity of the o-command relation can be observed in contrasts like the following:***

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*Cf. (Manning and Sag, 1999, p. 72).

**For a thorough argument and further evidence also motivated independently of binding facts see (Branco, 1996, 2000) and (Branco and Marrafa, 1997). In some languages, there can be an additional requirement that the subject be animated to qualify as a commander to certain anaphors. On this, see a.o. (Huang and Tang, 1991; Xue et al., 1994) about Chinese *ziji*.

***Lars Hellan p.c. See also (Hellan, 1988, p. 67).

Lars$_i$ fortalte Jon$_j$ om   seg selv$_{i/*j}$. (Norwegian)
Lars told   Jon about seg self
'Lars$_i$ told Jon$_i$ about himself$_{i/*j}$.'
Lars$_i$ fortalte Jon$_j$ om   ham selv$_{*i/j}$.
Lars told   Jon about him self
'Lars$_i$ told Jon$_i$ about him$_{i/*j}$.'

In the first sentence above, the reflexive cannot have the Direct Object as its antecedent given that the Subject is its only local o-commander in the non linear obliqueness hierarchy. In the second sentence, under the same circumstances, a pronoun presents the symmetric pattern: It can have any co-argument as its antecedent except the Subject, its sole local o-commander.

2.2.3. *Locality*

The *local domain* of an anaphor results from the partition of sentences and associated grammatical geometry into two zones of greater or less proximity with respect to the anaphor.

Typically, the local domain coincides with the immediate selectional domain of the predicator directly selecting the anaphor, as in the examples above in (3).

In some cases, there may be additional requirements that the local domain is circumscribed by the first selecting predicator that happens to be finite, bears tense or indicative features, etc.* One such example can be found in:**

Jón$_i$ segir   að [Maria$_j$ elskar   sig$_{*i/j}$].   (Icelandic)
Jón says-IND that Maria   loves-IND himself
'Jón$_i$ says-that [Maria$_j$ loves himself$_{*i}$ / herself$_j$].'
[Jón$_i$ segir   að [Maria$_j$ elski   sig$_{i/j}$].
Jón says-IND that Maria   loves-SUBJ himself
'[Jón$_i$ says-that [Maria$_j$ loves himself$_i$/herself$_j$].'

In the first sentence above, the verb in the embedded clause is Indicative and the local domain of its Direct Object is circumscribed to this clause as the reflexive cannot have the Subject of the upwards clause as its antecedent. The second sentence is identical to the first one except that the mood of the embedded verb is now Subjunctive. This leads to a change in the local domain of the reflexive: It can now have also the upwards Subject as its antecedent, thus revealing that its local domain is determined by the first selecting verb in the Indicative, which happens now to be the verb of the upwards clause.

In some other languages, there are anaphors whose local domain is the immediate selectional domain not of the directly selecting predicator but of the immediately

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*Vd. (Manzini and Wexler, 1987; Koster and Reuland, 1991; Dalrymple, 1993) for further details.
**Cf. Manzini and Wexler (1987, p. 417).

upwards predicator, irrespective of the inflectional features of the directly or indirectly selecting predicators. This seems to be the case of the Greek *o idhios*:*

O Yannis$_i$ ipe stin Maria [oti o Costas$_j$ pistevi [oti o
the Yannis told the Maria that the Costas believes that the
Vasilis$_k$ aghapa ton idhio$_{??i/j/*k}$]]. (Greek)
Vasilis loves the same.
'Yannis$_i$ told Maria that [Costas$_j$ believes that [Vasilis$_k$ loves him$_{??i/j/*k}$]].'

2.3. O-Bottom Positions and Exemption

For the interpretation of a anaphor to be accomplished, an antecedent has to be found for it. Such an antecedent is to be picked from the set of its o-commanders if the anaphor is a long-distance reflexive, or from the set of its local o-commanders if it is a short-distance reflexive. This requirement may not be satisfied in some specific cases, namely when the reflexive occurs in a syntactic position such that it is the least element of its o-command order, in an o-bottom position for short. In such circumstances, it has no o-commander (other than itself, if the o-command relation is formally defined as a reflexive relation) to qualify as its antecedent.

As a consequence, in some languages, the local domain for the short-distance reflexive which happens to be the least element of its local obliqueness order may be (re)set as containing the o-commanders of the reflexive in the local domain circumscribed by the immediately upwards predicator. One such example for a nominal domain can be found in:**

Gernot$_i$ dachte, dass Hans$_j$ dem Ulrich$_k$ [Marias$_l$ Bild von
Gernot thought that Hans the Ulrich Maria's picture of
sich$_{*i/*j/*k/l}$] überreichte. (German)
self gave
'Gernot$_i$ thought that Hans$_j$ gave Ulrich$_k$ [Maria$_l$'s picture of
himself$_{*i/*j/*k/}$herself$_l$].'

Gernot$_i$ dachte, dass [Hans$_j$ dem Ulrich$_k$ ein Bild von
Gernot thought that Hans the Ulrich a picture of
sich$_{*i/j/k}$ überreichte].
self gave
'Gernot$_i$ thought that [Hans$_j$ gave Ulrich$_k$ [a picture of
himself$_{*i/j/k}$]].'

In the first sentence above, the short-distance reflexive is locally o-commanded by *Maria* and only this nominal can be its antecedent. In the second sentence, the

reflexive is the first element in its local obliqueness hierarchy and its admissible antecedents, which form now its local domain, are the nominals in the obliqueness hierarchy of the immediately upwards predicator.

When there is no chance for such resetting, the reflexive turns out not to be interpretable:*

> *Sich$_i$ friert. (German)
> Self is_cold

In some other languages, this resetting of the local domain seems not to be available. In such cases, the short-distance reflexive is in the bottom of its local obliqueness order and is observed to be *exempt* of their typical binding regime. As a consequence, the reflexive may take antecedents that are not its o-commanders or that are outside of its local or immediately upward domains. It can even have so-called split antecedents, an option not available in non exempt positions:**

> Mary$_i$ eventually convinced her sister Susan$_j$ that John had better pay visits to everybody except themselves$_{i+j}$.

In some languages, long-distance reflexives may also be exempt from their binding constraint if they occur in the bottom of their o-command relation. In such cases, they can have an antecedent in the previous discourse sentences or in the context, or a deictic use:

> [O Pedro e   o   Nuno]$_i$ também conheceram ontem   a
> the Pedro and the Nuno   also   met   yesterday the
> Ana. Eles próprios$_i$ ficaram logo   a gostar muito
> Ana. They *próprios* stayed   immediately to liking much
> dela. (Portuguese)
> of_her
> '[Pedro and Nuno]$_i$ also met Ana yesterday. They$_i$ liked her very
> much right away.'

Such options are not available in non exempt positions:***

> A   Ana também conheceu ontem   [o Pedro e   o
> The Ana also   met   yesterday the Pedro and the
> Nuno]$_i$. Ela ficou logo   a gostar muito deles
> Nuno.   She stayed immediately to liking much of_them
> próprios$_{*i}$.
> próprios

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*Kiss (2003, p. 173).

**Zribi-Hertz (1989, p. 42). An anonymous reviewer clarified that in German, for examples similar to this one, it is not possible to have split antecedents.

***For further details and discussion, vd. (Branco and Marrafa, 1999).

'Ana also met [Pedro and Nuno]$_i$ yesterday. She liked them$_{*i}$
very much right away.'

Admittedly, an overarching interpretability condition is in force in natural languages requiring the "meaningful" anchoring of anaphors to antecedents. Besides this general requirement, anaphors are concomitantly ruled by specific constraints concerning their particular anaphoric capacity, including the sentence-level constraints in (3). When reflexives are in o-bottom positions, an o-commander (other than the reflexive itself) is not available to function as antecedent and anchor their interpretation. Hence, such specific binding constraints, viz. Principle A and Z, cannot be satisfied in a "meaningful" way and the general interpretability requirement may supervene them. As a consequence, in languages displaying so-called exemption from binding constraints, o-bottom reflexives appear to escape their specific binding regime to comply with such general requirement and its interpretability be rescued. Depending on the particular language at stake, the anaphoric links of exempt reflexives have been observed to be governed by a range of non sentential factors (from discourse, dialogue, non linguistic context, etc.), not determined by the sentence-level binding principles in (3).*

2.4. OPPOSITIONS

The plausibility of the binding constraints stated in (3) — in association with the convenient parameterisation of the auxiliary constructs in the Subsections above — is supported by their empirical adequacy, but also by the cogent symmetries holding between them. It is very unlikely that such non-trivial symmetries may be due to mere chance and this observation has sustained the conviction that the binding constraints are empirically well grounded and have something "natural" in them.

The recurrent complementary distribution of the admissible antecedents of a pronoun and of a short-distance reflexive in the same, non exempt syntactic position, in different languages from different language families, has perhaps been the most noticeable symmetry. But given also the recurrent complementary distribution of the admissible antecedents of a long-distance reflexive and of a non pronoun in the same, non exempt syntactic position, a similar symmetry is also found between these two other types of anaphors.

Another symmetry worth nothing is the one between short- and long-distance reflexives, on the one hand, and non pronouns and pronouns on the other hand. Both sorts of reflexives present the same binding regime but over o-command orders whose length is possibly different: The set of admissible antecedents of a short-distance reflexive is a subset of the set of admissible antecedents of a long-distance reflexive in the same, non exempt syntactic position. A pattern symmetric to this one is displayed by non pronouns and pronouns with respect to any given

*For further details vd. e.g. (Kuno, 1987; Zribi-Hertz, 1989).

syntactic position: The set of admissible antecedents of a non pronoun is a subset of the set of admissible antecedents of a pronoun.

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With the above introductory remarks on anaphoric binding constraints in place, the key observation to make with respect to the generalisations in (3) is that, when stripped away from procedural phrasing and non-exemption requirements, such generalisations instantiate the square in (2) giving rise to the following square of oppositions:
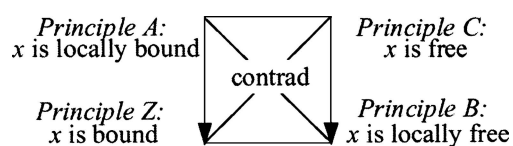

There are two pairs of *contradictory* constraints, which are formed by the two diagonals, (A, B) and (C, Z). One pair of *contrary* constraints (they can be both false but cannot be both true) is given by the upper horizontal edge (A, C). One pair of *compatible* constraints (they can be both true but cannot be both false) is given by the lower horizontal edge (Z, B). Finally two pairs of *subcontrary* constraints (the first coordinate implies the second, but not vice-versa) are obtained by the vertical edges, (A, Z) and (C, B).

Given this square of oppositions, the natural question to ask is whether this is a sign that binding principles are the visible effect of some underlying quantificational structure. A major point of this paper is to argue that this question can be answered affirmatively.

3. Phase Quantification

In the light of the considerations in Section 1, we proceed by showing that there is a square of duality associated with the grammatical constraints on anaphoric binding. Before this result can be fully 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 characterise quantification in general. For the sake of concreteness, consider a diagrammatic display of the semantics of aspectual adverbials:

(4)
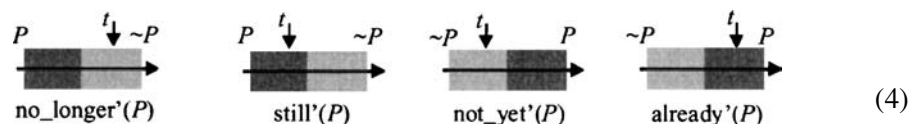
Very briefly, phase quantification requires the following ingredients: (i) an order over the domain of quantification; (ii) a parameter point t; (iii) a property P defining

a positive semiphase in a sequence of two adjacent, opposite semiphases; and (iv) the starting point of a given semiphase.

For the analysis of aspectual adverbials in terms of phase quantification, the order of (i) is the time axis; the parameter point t of (ii) is the reference time of the utterance; the relevant property P of (iii) denotes the instants where the proposition modified by the adverbial holds (with the adverbials *no longer* and *still* bearing the presupposition that semiphase P precedes semiphase $\sim P$, and *not yet* and *already* bearing the presupposition that $\sim P$ precedes P); and the starting point in (iv) is $I(R,t)$, the infimum of the set of the closest predecessors of t which form an uninterrupted sequence in phase R.*

Given these correspondences, the aspectual adverbials can be analysed as expressing the following generalised quantifiers:

still':
$\lambda P.\text{every'}(\lambda x.(I(P,t) < x \leq t),P)$

not_yet':
$\lambda P.\text{no'}(\lambda x.(I(\sim P,t) < x \leq t),P)$

no_longer':
$\lambda P.\text{not\_every'}(\lambda x.(I(P,t) < x \leq t),P)$

already':
$\lambda P.\text{some'}(\lambda x.(I(\sim P,t) < x \leq t),P)$

(center: dual)

(5)

4. The Quantificational Force of Anaphors

With these introductory notes in place, the empirical generalisations captured in the definition of binding principles in (3) can be argued to be the effect of the phase quantificational nature of the corresponding nominals. In the present section, we show how anaphoric nominals can be analysed as expressing one of four quantifiers acting on the realm of reference markers arranged on the basis of the grammatical obliqueness order of their clauses.

4.1. PHASE QUANTIFICATION INGREDIENTS

Phase quantification here is assumed to unfold not over entities of the extra-linguistic universe, but over entities in the universe of grammatical representations, vz. reference markers (Karttunen, 1976; Kamp, 1981; Heim, 1982; Seuren, 1985). Its major ingredients are set up as follows:

(i) *Order*: The relevant order has reference markers as elements, arranged on the basis of the o-command relation involving their corresponding nominal expressions, and assumed to be a reflexive relation — for ease of reference and when there is no risk of confusion, we refer to this order as the o-command relation (of the markers);

(ii) *Parameter point*: t is set up as a, the reference marker of the antecedent for the anaphoric nominal at stake;

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*Vd. (Löbner, 1987, 1989) for a thorough definition.

(iii) *Phase property*: P is set up as D, denoting the set of markers of the expressions that are in what we term as the grammatical domain of the anaphor.

For an anaphoric nominal n in a given sentence s, the positive semiphase D is determined by the position of n in the obliquencess order which n enters in s: Given r, the reference marker of n, positive semiphase D_r is a stretch containing r *and the markers that are less than or equal to r in the obliqueness order such that the closest D_r neighbour of semiphase $\sim D_r$ is local with respect to r* — to be sure, this grammatical domain is thus established under the specific command ordering and locality boundaries that will happen to be associated with the specific occurrence of n via the suitable parameterisation of the auxiliary constructs for binding, as discussed in Section 2.2.

It is of note that the positive phase D — corresponding to what we term as the *grammatical domain* — is not necessarily the *local domain* of the corresponding anaphor tough it builds on the notion of locality that is relevant to define local domains. From the definition above, in case $\sim D_r$ is presupposed to precede D_r, the first predecessor of r in D_r is local with respect to r — D_r contains the local o-commanders of r. But in case semiphase D_r is presupposed to precede $\sim D_r$, D_r is such that the last successor of r in it (r itself) is local with respect to r — D_r contains the o-commanders of r, that are local and possibly not local with respect to r.

Given these ingredients for phase quantification and the appropriate replacements in the square in (5), one gets four phase quantifiers that we termed $\mathbf{Q}_Z$, $\mathbf{Q}_B$, $\mathbf{Q}_C$ and $\mathbf{Q}_A$.* These quantifiers enter the square of duality and align with other generalised quantifiers of similar quantificational force at each of the corners:

every'(R), still', $\mathbf{Q}_Z$,...   no'(R), not_yet', $\mathbf{Q}_B$,...

dual   (6)

not_every'(R), no_longer', $\mathbf{Q}_C$,...   some'(R), already', $\mathbf{Q}_A$,...

As we are going to check in the Subsections below, these four phase quantifiers ensure the same empirical generalisations as secured by the four binding constraints stated in (3).

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*The definitions of aspectual phase quantifiers and, in particular, of their restrictors in (5) were originally designed in (Löbner, 1987) for the continuous order of time points, represented in the line of real numbers. The order of reference markers to be used here is discrete instead, implying that it is not the case that between two elements, there is always another one. Hence, in order not to exclude any element of the domain of quantification from possibly playing a role as antecedent — in particular, the minimal elements —, the conditions defining the restrictors in (5), when adapted for $\mathbf{Q}_Z$, $\mathbf{Q}_B$, $\mathbf{Q}_C$ and $\mathbf{Q}_A$, are slightly relaxed and the '$<$' condition is replaced by the '$\leq$' condition.

4.2. SHORT-DISTANCE REFLEXIVES

The quantifier expressed by short-distance reflexives is associated with the presupposition that $\sim D.D$. It receives the following definition:

$$\boldsymbol{Q}_A: \lambda P.\text{some'} (\lambda x.(I(\sim P, a) \leq x \leq a), P)$$

This is easily interpreted against the diagram corresponding to an example sentence like *Kim said Lee thinks* [*Max$_i$ hit himself$_i$*]. In the diagram below, k, l, m and h stand, respectively, for the reference markers of Kim, Lee, Max and $himself$; and $x_1, \ldots, x_n$ stand for the markers not in the sentential obliqueness relation of h, including those possibly introduced in other sentences of the discourse or available in the context (Hasse diagrams are displayed with a turn of 90 degrees right):
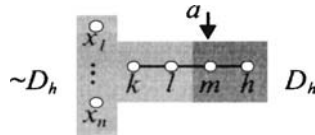
In this case, $\mathbf{Q}_A(D_h)$ is satisfied iff between the bottom of the uninterrupted sequence $\sim D_h$ most close to the antecedent a and a inclusive, there is at least one reference marker in D_h. As $\sim D_h$ precedes D_h, this amounts to requiring that a be in D_h, the local domain of h, and consequently that a be a local o-commander of h, which matches the requirement of Principle A in (3).

Correct empirical prediction requires however the definition of negative semiphase to be refined and a more accurate definition of $\sim D$ to be provided. Note that the example sentence used above helps to illustrate a case where the nominals in the sentence contribute reference markers for both the negative and the positive semiphases. Other examples, such as *Max$_i$ hit himself$_i$*, show that it is also possible that the only markers in the negative phase—represented as $x_1, \ldots, x_n$ in the diagram—are those contributed by other sentences not containing the reflexive or by the context. In such cases of non embedded sentences, the denotation of $\lambda x.(I(\sim D_h, a) \leq x \leq a)$, the restrictor of $\mathbf{Q}_A$, would be empty, and $\mathbf{Q}_A(D_h)$ would not be satisfied.

The adaptation of phase quantification—originally designed for a linear order, such as the time line—to the non-linear order of reference markers thus motivates the following two refinements.

On the one hand, we are taught that negation of the positive phase P is slightly more sophisticated than the mere complement set operation, $\bar{P}$. It also involves the lifting of the dual of the complement set, $(\bar{P}^\partial)_\perp$, with $\perp$ equals to the bottom of P (m in the working example above) when there is the presupposition that $\sim P.P$.*

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*The motivation for a dual version of this definition of negative semiphase will become apparent in the next subsections that discuss phase quantifiers with the inverse presupposition that $P \sim P$.

With this fine-tuned definition of the negative semiphase, the diagrammatic display for our working example becomes:
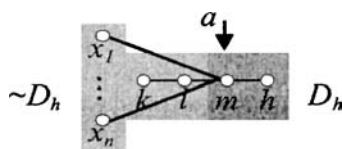
On the other hand, this example also helps to make apparent that in the non-linear order of reference markers, there may be no infimum, but only minimal elements. Accordingly, $I(R, t)$ should be set as standing for the infimum, when such an element exists, or else for any one of the minimal elements of the set that includes t and the possible closest predecessors of t which form an uninterrupted sequence in phase R.

With these adjustments in place, $\mathbf{Q}_A(D_h)$ is satisfied iff between a minimal element in $\sim D_h$ preceding a and the antecedent a inclusive, at least one marker is in D_h. This correctly matches the requirement of Principle A that a be in D_h, i.e. that admissible antecedents are to be found in the set of local o-commanders of the short-distance reflexive.*

Binding phase quantifier $\mathbf{Q}_A$ thus shows positive existential force and short-distance reflexives align in the square of duality in (6) with items like *some N, already, possibly*, etc.

4.3. PRONOUNS

The phase quantifier expressed by pronouns, in turn, lies at the same corner as the quantifiers no'(R) or not_yet' in (6):

$$\boldsymbol{Q}_B : \lambda P.\text{no'} (\lambda x.(I(\sim P, a) \leq x \leq a), P)$$

The presupposition conveyed by these anaphors is also that $\sim D.D$, and $\mathbf{Q}_B$ is easily grasped when considering the diagrammatic description of an example like *Kim said Lee$_i$ thinks [Max hit him$_i$]*, where h is the reference marker of *him*:
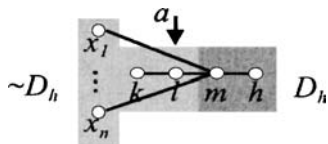
$\mathbf{Q}_B(D_h)$ is satisfied iff between a minimal element of $\sim D_h$ preceding a and the antecedent a inclusive, no reference marker is in D_h. This implies that a is

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*The case where an anaphor lies at the bottom of the positive semiphase, which is then a singleton, is discussed in subsection 4.5.

in $\sim D_h$, i.e. it has to be outside the local domain of the pronoun, thus matching the generalisation captured by Principle B. In this case, $\sim D_h$ includes not only the markers k and l of Kim and Lee, in the upwards clause, but also $x_1, \ldots, x_n$ thus allowing for non-sentential anaphoric links for the pronoun (including those that are discourse- or context-driven, deictic, etc.).

Note that in the previous subsection, the negative semiphase was discussed to be more refined than the mere complement set of D. Sentences with pronouns with split antecedents — such as Kim_i $said$ Lee_j $thinks$ [Max hit $them_{i+j}$] — show that the set of markers in the negative phase has an even slightly more sophisticated composition. The negative semiphase contains the markers that are not in the positive semiphase P and also, following an approach inspired in (Link, 1987), all their possible individual sums. Using Link's recursive plural operator '$*$', a negative semiphase $\sim P$ can thus be further refined as the closure of the set found in the previous subsection under this operator, that is $(*\bar{D}^{\partial})_{\perp}$. In the next diagrams, for the sake of perspicuity, however, these individual sums in the negative semiphases will not be displayed.

4.4. NON-PRONOUNS

In contrast to the quantifiers studied in the previous two subsections, expressed by short-distance reflexives or pronouns, the quantifiers expressed by non-pronouns or long-distance reflexives are associated with the presupposition that the positive semiphase precedes the negative semiphase.

In what concerns $\mathbf{Q}_C$, expressed by non-pronouns, it appears at the same corner of the square in (6) as quantifiers like not_every'(R), no_longer', etc.:

$$\mathbf{Q}_C: \lambda P.\text{not\_every'} (\lambda x.(I(P, a) \leq x \leq a), P)$$

Let us consider a first version of the diagram for the example [Kim_i's $friend$] $said$ the boy_i $thinks$ [Lee saw Max], where b is the marker corresponding to the boy:
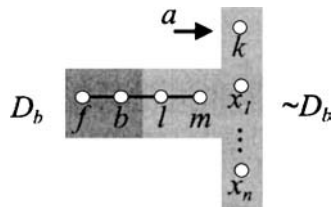

An admissible antecedent a of b is to be required to occur in $\sim D_b$, implying that a cannot be an o-commander of b, thus rendering the same constraint as expressed in Principle C.

As for the other types of anaphors, the negative semiphase $\sim D$ is closed under the recursive plural operator (though for the sake of perspicuity, the details of this structure are not displayed in the diagram). Correct empirical prediction requires however that the definition of the negative semiphase be refined and a more accurate definition of $\sim D$ be provided, in line with the refinements previously motivated by the quantifiers associated with the inverse presupposition that $\sim D.D$.

Note that for $\mathbf{Q}_C(D_b)$ to be satisfied, between the bottom of D_b and the antecedent a inclusive, not every reference marker is in D_b. In examples as the one above, the denotation of $\lambda x.(I(D_b, a) \leq x \leq a)$, the restrictor of $\mathbf{Q}_C$, is always empty: It is not the case that $I(D_b, a) \leq a$ because when $a = k$ (or $a = x_i$, for any i), a is not comparable to any element of D_b, including $I(D_b, a)$. Hence, not_every' $\lambda x.(I(D_b, a) \leq x \leq a), D_b)$ is false whatever marker, k or x_i, happens to be taken as the antecedent for b. As a consequence, the specific anaphor resolution in the example above would be incorrectly ruled out.

Here we find again motivation to consider that when phase quantification operates on non-linear orders of reference markers, negation of the positive phase P is slightly more sophisticated than the mere complement set. In particular, we find motivation for a definition of the negative semiphase which is the order-theoretic dual of the definition previously found for quantifiers associated with the inverse presupposition that $\sim P.P$. We are taught that negation of P is $(*\bar{P})_\perp$, involving the lifting of the complement set, closed under '*', with $\perp$ equals to the top of P (b in the working example above) when there is the presupposition that $P. \sim P$.

With this fine-tuned definition of the negative semiphase, the diagrammatic display for our working example (without the closure by '*') becomes:
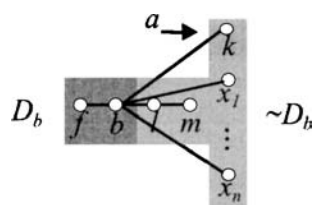

This specification of the negative semiphase correctly ensures that $\mathbf{Q}_C(D)$ is satisfied iff between the bottom of D_b and the antecedent a inclusive, not every marker is in D_b; that is, iff a is not in D_b and, therefore, is not an o-commander of b, as stated in Principle C.

4.5. LONG-DISTANCE REFLEXIVES

Turning to long-distance reflexives, we consider the working 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*]. Its diagram can be displayed as follows, where *e* is the marker of the long-distance reflexive:
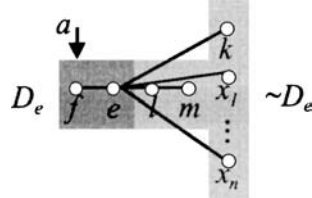
The phase quantifier expressed by long-distance reflexives has positive universal force and can be found at the same corner of the square in (6) as the quantifiers every'(R) or still':

$$Q_Z: \lambda P.\text{every'} (\lambda x.(I(P, a) \leq x \leq a), P)$$

As with short-distance reflexives, the antecedent *a* is here required to occur in D_e though the presupposition conveyed now is that the positive semiphase D is followed by the negative semiphase $\sim D$. Taking into account the definition of the positive phase D in Section 4.1, the antecedent *a* is thus required to be an o-commander — local or not — of the marker *e* of the anaphoric nominal.

The semantics of the phase quantifier corresponding to long-distance reflexives is such that for $\mathbf{Q}_Z(D_e)$ to be satisfied, between the bottom of the uninterrupted sequence D_e closest to an admissible 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 imposing that the admissible antecedents be found in the set of o-commanders of the long-distance reflexive, as captured by Principle Z.

It is also worth checking what happens when anaphors occur in positions where exemption from the corresponding binding regime may be observed, i.e. anaphors in the bottom of the positive semiphase D. Under the phase quantificational analysis of binding constraints that is being presented, to a marker *m* in the bottom of D, there corresponds the maximum "shrink" of D, as this is the singleton whose sole element is *m*. This maximum shrink has a disturbing impact for the interpretation of anaphors expressing phase quantifiers for which the antecedent *a* is to be found in D, namely $\mathbf{Q}_A$ and $\mathbf{Q}_Z$. In these cases, for the possible antecedent *a* to be in D and the relevant phase quantification to be satisfied, *a* can only be identified with the reflexive *m* itself, in a sort of an anaphoric loop.

The reflexives would thus remain to be semantically interpreted if this specific case of phase quantifier satisfaction is not supplemented with a suitable anaphoric linkage. Hence, a supervenient resolution (necessarily to a non o-commander given

that *m* is in the o-bottom position of its binding domain) may be observed to take place in languages with exempt reflexives, thus inducing the so-called "exemption" effects mentioned in Section 2.3, and illustrated with examples from English and Portuguese.

In languages not served with this option, the reflexive may end up semantically locked in this anaphoric loop, and remains uninterpreted, thus inducing the unacceptability of the constructions where it occurs — as illustrated with examples from German also in Section 2.3.

5. Discussion: Anaphoric Binding

In strictly empirical terms, there are no consequences of the phase quantificational analysis just presented other than ensuring that the generalisations captured by "binding theory" are secured, namely as these generalisations unfold from the constraints in (3) together with the parameterisation allowed by the auxiliary constructs in Section 2.2.

In more theoretical terms, the results now reported may shed new light over a number of interesting research issues, to whose discussion we turn now.

5.1. LEXICALISATION

The focus of the present paper is on the concept of a phase quantificational approach for anaphoric binding constraints. But once the plausibility of this approach is secured by arguments supporting it, a major set of adjacent research issues will arise that gravitate around the question of how to better implement such an analysis in mainstream grammatical frameworks. While the technical discussion of the integration of binding phase quantifiers into formal grammars of natural languages is out of the scope of the present paper, it is noteworthy that this approach paves the way to an elegant interleaving of binding constraints with the remaining aspects of the grammatical representation of nominal anaphors. Under this approach, the empirical generalisations captured in the definition of binding principles are just the effect of the specific quantificational force of the anaphors lexically encoded in their semantic values.

The view that binding principles are to be lexically associated with anaphors were first advocated in (Dalrymple, 1993), though on considerably different grounds. The arguments for the phase quantificational approach now discussed are independent of the specific grammar framework that turns out to be opted for to implement this approach and thus constitute a strong point in favor of the lexicalisation of binding constraints in any framework.

5.2. LINGUISTIC UNIVERSALITY AND LANGUAGE SPECIFIC "GAPS"

The universality of grammatical constraints on anaphoric binding has been noticed as a striking feature given the parameterised validity of these constraints across

natural languages. When envisaged as a set — forming the so-called "binding theory" —, binding principles have been considered one of the best candidates to be a module of universal grammar. Given the linguistic universality of quantification, if binding "principles" as those defined in (3) are the noticeable effect of quantificational devices, then there is there the justification for their being universally operative across natural languages.

While binding "theory" has been seen as a universal module of grammar, it is a fact that not all languages have anaphoric nominals of each one of the four binding types: For instance, English has no nominals with anaphoric capacity of type Z, and Vietnamese is reported not to have type C anaphors (Lasnik, 1989, p. 153).* The reason for the occurrence of these "gaps" in spite of the universality of binding "theory" follows now also in simple terms.

In other squares of duality, it is possible that not every corner of the square is "lexicalised", an issue discussed at length by Löbner (1987, p. 65). With respect to English, for instance, this author noted that the square of duality concerning deontic possibility happens to have only two lexicalised corners, *right* and *duty*, while in the square of classical logic only the three corners, *some*, *every* and *no* are lexicalised, just to mention two examples.

Likewise, with respect to the phase quantification expressed by anaphors, it is natural to admit that there might be "gaps" in the corresponding square of duality: For a given language, some corners of this square may not be expressed by any anaphoric nominal of that language.

5.3. BINDING "THEORY" AND ITS PRIMITIVES

The intriguing symmetries between the definitions of binding constraints have been a source of puzzlement and challenge in the last decades for the research on nominal anaphora. These symmetries fostered the view that grammatical binding constraints belong to a coherent set or, as many have called it, to a binding "theory". They have inspired a number of accounts that try to justify them in terms of — and sometimes try to take them as the justification for — some underlying or general cognitive, functional, pragmatic, "economy"-driven, etc. foundations of language use or of the language faculty (vd. a.o. Levinson, 1991; van Hoeck, 1997; Reuland, 2001; Piñango, 2001).

The analysis presented in this paper provides for a notoriously elegant way of relating the different binding constraints with each other in a compact "theory" that dispenses with special purpose grammatical features or diacrits. While presenting a formally precise account of the relations among binding constraints, this analysis offers a straightforward justification for the "symmetries" among them: The latter are just the kind of "symmetries" that hold among the corners of squares of duality.

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*See also Levinson's (1991, pp. 133–140) consideration of languages that possibly lack reflexives, though the low quality of the data available renders it difficult to draw solid conclusions.

It is of note that a new line of research may have been uncovered here, a research line where the relations among binding constraints are not a puzzling isolated natural language phenomenon anymore: In order to search for the possible underlying or more primitive foundations of grammatical binding constraints, one should consider searching for this type of primitives in what concerns quantification in the grammar of natural language in general.

6. Discussion: Quantification and Reference

6.1. QUANTIFICATION

Many authors have stressed the view that there is no correspondence between surface and logical form of quantificational expressions of natural languages. Löbner emphasised this non-correspondence by pointing 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.

Other important implications for our understanding of quantification in natural languages might have been uncovered as well by the results presented above. Quantification is extended to universes which are possibly non-linearly ordered.* And more important, quantification is extended to universes whose elements are not entities of the "extragrammatical" world, but entities of the "intra-grammatical" universe 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. $\mathbf{Q}_A, \mathbf{Q}_Z, \mathbf{Q}_B$ or $\mathbf{Q}_C$, 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.

6.2. SYMMETRIC DUALITIES

Finally, it is worth considering the implications of the results reported here for the overall semantic make up of nominals.

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*This is the case when anaphors appear to be Subject-oriented due to a non-linear obliqueness hierarchy — cf. Section 2.2.

The shared wisdom is that nominals convey either quantificational or referential force, and 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 (cf. a.o. Neale, 1993, Larson and Segal, 1995). For the sake of the argument, let us assume 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 developed in this paper imply that nominals with "primary" referential force (*he*, *the book*, *John*...) may 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 (*every man*, *most students*...) do.

This duality of semantic behaviour, however, turns out not to be that much surprising if one observes a symmetric duality with regards to quantificational nominals, apparent when they are able to 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., Kamp and Reyle, 1993, Section 4.1.2) implies that nominals with "primary" quantificational force may 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 and 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.

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