

A Dynamic Theory of Binding

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Binding Theory (Chomsky 1981:183ff) is generally taken to describe representational conditions on the distribution of noun phrase types. Within the Minimalist Program, where all conditions are output conditions, the relevant representation should be Logical Form (Chomsky 1995:208). This paper argues for a different view, where the principles of the Binding Theory fall out from a dynamic derivational process of assigning reference to noun phrases. The process is dynamic in that it proceeds in tandem with the structure building process of Merge (Chomsky 1995:226).¹

1. Classical Binding Theory

This paper starts from the classical binding theory of Chomsky 1981 (p. 183ff; see also Chomsky 1986:164ff, Chomsky & Lasnik 1995:100). I take the following to summarize the principles of the classical binding theory:

- (1) For a local domain D:
- a. An **anaphor** is bound in D
 - b. A **pronoun** is free in D
 - c. An **R-expression** is free

Binding (being *bound*) is defined as in (2)(Chomsky 1981:184):

- (2) α binds β iff α c-commands β and α and β are coindexed²

The *local domain D* relevant to the principles of the binding theory is defined in various ways. The core intuition appears to be that D is the minimal maximal projection dominating the anaphor/pronoun that contains either *tense* or a *subject* (e.g. Lasnik 1989:1).

The principles of the binding theory describe the interpretation of the italicized noun phrases in (3):

- (3) a. Bill believes that [_D *John* knows *himself* well]
b. * *Bill* believes that [_D Mary knows *himself* well]
(4) a. *Bill* believes that [_D John knows *him* well]
b. * Mary believes that [_D *John* knows *him* well]
(5) a. * Mary believes that [_D *he* knows *John* well]
b. * *He* believes that [_D Mary knows *John* well]

(3) shows that *himself* refers to a noun phrase within domain D (*John* in (3a), none in (3b)). (4) shows that *him* may refer to a noun phrase outside domain D (*Bill* in (4a)), but not to a noun phrase within domain D (*John* in (4a) and (4b)). (5) shows that *he* cannot refer to the same entity as *John*, regardless the domain D.

In classical binding theory, the principles in (2) are generally taken to apply at S-structure (Chomsky & Lasnik 1995:106). (6) shows that principle A need not be satisfied at D-structure:

- (6) a. D-structure: [_D [e] seems to *himself* [*John* to be intelligent]]
- b. S-structure: [_D *John* seems to *himself* [[t] to be intelligent]]

(7) shows that principle C applies prior to LF (assuming Quantifier Raising of the quantified expression *everyone that John knows* at LF):

- (7) a. S-structure: * *He* admires [everyone that *John* knows]
- b. LF [everyone that *John* knows] [*he* admires [t]]

Ignoring many concomitant issues, this summarizes the classical binding theory.

2. Minimalist Binding Theory

From the perspective of the Minimalist Program, two aspects of the classical binding theory are not acceptable.

First, the definition of *binding* in (2) relies crucially on the notational convention of indexing (cf. Chomsky 1995:217 fn 53). Coindexing *expresses*, rather than *defines*, the existence of a binding relation between two phrases (cf. Zwart 1997a).³

Second, the Minimalist Program aims to describe phenomena in terms of requirements holding at the interfaces (PF and LF) between the grammar (the computational system C_{HL}) and components processing sound and meaning (Chomsky 1995:222f). This suggests that the principles of the binding theory be taken as interpretive principles applying at LF (see Chomsky 1995:192-193, 205-211).⁴

Both considerations conspire to yield a different formulation of the principles of the binding theory (Chomsky 1995:211):

- (8) a. If α is an **anaphor**, interpret it as coreferential with a c-commanding phrase in D.
- b. If α is a **pronominal**, interpret it as disjoint from every c-commanding phrase in D.
- c. If α is an **R-expression**, interpret it as disjoint from every c-commanding phrase.

It is easy to see that the principles in (8) describe the interpretations of the sentences in (3)-(5) correctly.

3. A Derivational Approach

The minimalist reformulation of the binding principles entails the following:

- (9) 1. phrases are defined as either anaphors, pronominals, or R-expressions;
2. interpretive procedures at LF recognize the status of phrases as anaphors, pronominals, or R-expressions;
3. the interpretation procedure at LF calculates the size of the local domain D;
4. the interpretation procedure at LF recognizes the relation c-command;
5. the interpretation procedure operates on the entire LF-representation yielded by C_{HL} .

I will refer to the interpretation procedure in (9) as an ‘all at once’ operation: the entire LF-representation is processed by the interpretational procedure at LF.

(9.1) and (9.2) are uncontroversial.⁵ (9.3) is generally tacitly assumed, and apparently unproblematic. But (9.4) and (9.5) raise interesting questions.

One such question is: how is it that the LF interpretation procedure only considers elements c-commanding α as potential antecedents for α ? Following Epstein (1995), we are able to provide a principled answer to this question. Epstein argues that grammatical relations are restricted to pairs of elements (α, β) , where α c-commands β , because only α enters into an operation of merger with β (or a node containing β).

To appreciate this result, consider the phrase structure building process in the Minimalist Program (Chomsky 1995:241f).

Whereas in previous stages of generative grammar phrase structure was the result of the operation of context free rewrite rules, combined with a process of lexical insertion at the terminal nodes, the Minimalist Program makes no formal distinction between lexical insertion and the generation of structure. Structure is the result of two elements *merging*. Merger is a derivational process, yielding successive stages of phrase structure ‘under construction’, and subject only to a limited set of basic conditions. One of these conditions specifies that α cannot be merged to a subpart of β (the *extension condition*, Chomsky 1995:190).⁶

Epstein (1995) notes that at any given stage in the derivation (say, the point where α has merged with β), α c-commands β , as well as every term contained in β . But elements added by later operations of Merge are never c-commanded by α . The definition of c-command then follows if the ‘c-command properties’ of α are fixed *once and for all* at the point in the derivation where α is merged to the structure.

We can now say that the LF interpretation procedure is sensitive to the ‘c-command properties’ of the elements in the LF-representation. However, Epstein’s observations raise the following question. Can we, by analogy to the definition of c-command as a function of Merge, define the binding relations between elements as a function of Merge as well? In other words, can we replace the ‘all at once’ operation in (9)(especially (9.5)) by a stepwise, derivational procedure? This would allow us to dispense with the LF procedure for the interpretation of noun phrases (i.e. for binding).

I argue in this paper that we can, and that there are in fact empirical arguments in support of a derivational definition of binding relations.

4. Inner and Outer Indices

Before proceeding, let me explain a notational device which is employed here (adapted from Heim 1992, discussed in Tancredi 1992).

The ‘reference’ of noun phrases may be considered a) autonomously and b) as a function of a syntactic (binding) relation.⁷ Heim (1992) and Tancredi (1992) employ indices to express both types of reference, with *inner indices* representing the autonomous referential properties of noun phrases, and *outer indices* representing referential properties as a function of a grammatical relation. All noun phrases bear an inner index, as in (10a). I propose that only dependent elements bear an outer index, as in (10b):⁸

- (10) a. [NP₁]
 b. [NP₁]₂

All noun phrases, including anaphors and pronominals (including the empty element *pro*) represent an individual concept, hence bear an inner index in our notation. Anaphors and pronouns differ from R-expressions in that the individual concept represented by anaphors and pronouns is *variable*, whereas with R-expressions, it is *fixed* (ignoring variability provided by the discourse situation). The ‘referentiality’ of pronouns and anaphors is expressed in the selection of their morphosyntactic features (proximal, 3d person, plural, masculine, etc.), which restrict the properties of the individual concept represented by the anaphor or pronoun. Binding links these variable referential elements to fixed referential elements. The (more restricted) referential properties so acquired are represented by outer indices in our notation.

The characterization of pronouns and anaphors as variable referential elements suggests a definition of noun phrase types as in (11):

(11)

referential	variable	type
+	+	anaphor, pronoun
+	-	R-expression
-	+	(does not exist)
-	-	PRO

See Zwart (1997a) for further discussion.

5. Index Assignment

The process of index assignment proposed here is intended as a model of how the grammar tracks referential properties of noun phrases. The core of the proposal is that these referential properties are fixed at the moment of merger.

The index assignment procedure involves the following steps:

- (12)
1. Assign a different inner index to every noun phrase α at the point in the derivation where α is merged.
 2. Assign the inner index of α as the outer index of a variable referential element δ at the point in the derivation where α is merged with β dominating δ .

The index assignment procedure expresses that obviation is the norm (as in Lasnik 1976), the difference with earlier implementations being that obviation is ensured in a bottom-up fashion, rather than in a top-down fashion.

Thus (13a), repeating part of (5a), is derived by the succession of steps in (13b):

- (13)
- a. He knows John well
 - b.
 1. MERGE *knows* with *John*, yielding {knows,John}
ASSIGN INDEX to *John* {knows,John₁}
 2. (other steps, yielding XP containing *John*)
 3. MERGE *he* with *XP*, yielding {he,XP}
ASSIGN INDEX to *he* {he₂,XP}

He in (13a) can receive an outer index from a newly merged noun phrase, but that index is different from the index of *John*, by (12.1). Consider (14a), derived by the steps in (13b) and the additional steps in (14b):

- (14) a. *Bill* says *he* knows John well
- b.
1. (steps yielding YP containing *he*₂ knows *John*₁ well)
 2. MERGE *says* with YP yielding {says, YP}
 3. (steps yielding ZP containing *says he*₂ knows *John*₁ well)
 4. MERGE *Bill* with ZP yielding {Bill, ZP}
 - ASSIGN INDEX to *Bill* yielding {Bill₃, ZP}
 - ASSIGN OUTER INDEX 3 to *he* yielding [*he*₂]₃

Here the circumstance that *he* is linked to *Bill* is expressed by the additional outer index of *he*, which is identical to the (inner) index of *Bill*. The example shows that different inner and outer indices do not necessarily conflict. The outer index 3 further restricts the inherent reference of *he*, represented by the inner index 2.

6. The Principles of the Binding Theory

The principles of the Binding Theory can be reformulated in terms of the indexing procedure in (12).

6.1 Principle C

Principle C follows straightforwardly from the obviate indexing procedure in (12.2). There is a little more to it, though, since Principle C is not bled by movement (the ‘reconstruction’ property of Principle C).

In (15a), derived via the steps in (15b), the inner index and the outer index of *he* conflict (angled brackets surround copies of moved elements):

- (15) a. * *John*, *he* knows <*John*> well
- b.
1. (steps yielding YP containing *he* knows *John*₁ well)
 2. MERGE *John* with YP yielding {John₁, YP}
 - ASSIGN OUTER INDEX 1 to *he* yielding [*he*₂]₁

Here the indexing follows the principles in (12), still (15a) is ungrammatical. The index notation employed here obscures that the reference of *he* in (15a) is not just different from the reference of *John*, but in fact complementary to it. We could express this by writing the outer index of *he* as -1, indicating that it is biased to be complementary to the index of the R-expression it c-commands. After step b.2 in (15), assignment of the outer index of *John* to *he* yields an

object like (16), expressing referential properties which are arguably not interpretable:

(16) [he_2]_{1,-1}

Thus, it appears to be a defining characteristic of R-expressions that they force the indices on newly merged elements to be complementary to their own index.

6.2 Principle B

Principle B operates identical to Principle C within the local domain D. Thus, within the domain D (not further defined here), newly merged noun phrases receive a different index from pronominals already contained in the structure:

- (17) a. John knows him well
- b.
1. MERGE *knows* with *him*, yielding {knows,him}
ASSIGN INDEX 1 to *him*, yielding [him_1]
 2. further steps, yielding *XP* containing *knows him₁*
 3. MERGE *John* with *XP*, yielding {John, XP}
ASSIGN INDEX 2 to *John*, yielding John₂

Since *John* cannot have an outer index (its reference is already fixed), raising of *him* across *John*, as in (18), has no effect on the interpretation of (17a):

(18) Him, John knows <him> well

Therefore it is not clear whether pronominals actually require the index of newly merged noun phrases to be complementary to their own index. Outside domain D, such a requirement certainly does not apply, as the derivation of (14a), here repeated as (19), shows (the domain D uncontroversially identified with the embedded clause):

(19) Bill₃ says [_D [he_2]₃ knows John₁ well]

In (19), the indices 2 and 3 must not conflict, or else the sentence would be uninterpretable (cf. the discussion around (15)).

6.3 Principle A

Principle A requires anaphors to adopt as their outer index the index of a newly merged noun phrase within domain D:

- (20) a. *John knows himself*
- b.
1. MERGE *knows* with *himself*, yielding {knows, himself}
 - ASSIGN INDEX 1 to *himself*, yielding [himself₁]
 2. further steps, yielding *XP* containing *knows himself*₁
 3. MERGE *John* with *XP*, yielding {John, XP}
 - ASSIGN INDEX 2 to *John*, yielding John₂
 - ASSIGN INNER INDEX 1 to *himself*, yielding [himself₁]₂

The strongest hypothesis appears to be that anaphors need to adopt as their outer index the index of the *next* noun phrased merged to the structure.⁹ This derives much of the locality features of anaphor binding, but not quite, in view of the impossibility of having anaphors in the position of subject of a tensed clause (=domain D):

- (21) * *John knows that* [_D *himself/herself* is intelligent]

Apparently, the ‘search for an outer index’ is abandoned as soon as the structure is extended beyond a local domain D. As a result, the subject of a tensed clause can never be interpreted as an anaphor, and languages will generally lack morphological spell outs of nominative anaphors (cf. note 5).¹⁰

6.4 Summary

The preceding discussion suggests, perhaps prematurely, that the LF-interpretation procedure of the minimalist binding theory can be reformulated as a derivational reference fixing procedure, working in tandem with the structure building process Merge. The reference fixing procedure involves the following features:

- (22) *Features with the status of virtual conceptual necessity*
1. Universal Grammar (UG) distinguishes fixed referential elements (R-expressions) and variable referential elements (anaphors and pronominals).
 2. Variable referential elements get their reference fixed by other noun phrases merged with the projection containing them.
 3. The reference fixing procedure is sensitive to the definition of local domains.
 4. Within the class of variable referential elements, UG distinguishes locally fixed referential elements (anaphors) and locally variable referential elements (pronominals).
 5. Languages differ in whether they acknowledge the distinction between locally fixed referential elements and locally variable

referential elements in the spell out operation (mediated by the morphology component).

(23) *Theoretically contingent features*

6. The reference of variable referential elements is fixed at the point in the derivation where the fixing element is merged with the projection containing the variable referential element.
7. Local domains are determined concomitantly with the structure building operation Merge (instead of read off of the LF-representation).

Point 6 is the crucial hypothesis investigated in this paper. Point 7 is a necessary consequence of this hypothesis. It gains plausibility from the consideration that local domains are generally determined on the basis of an opacity factor (tense or a subject), the presence of which could seal off the local domain as soon as it is merged to the structure.¹¹

The discussion so far has ignored the question of whether nonlocally 'bound' pronouns acquire a fixed reference by the same process as anaphors. I have tacitly assumed that they do (cf. the discussion of (14)), but points 1-7 make no explicit statement about the mechanism by which pronouns may get their reference fixed (certainly not obligatorily or exclusively as a function of the operation Merge). I will continue to assume that pronouns, if 'bound' by c-commanding antecedents, are 'nonlocal anaphors', while noting that this is probably incorrect and that the system as described so far is unclear about this point.

7. Empirical Support for the Derivational Approach

The derivational approach to binding developed here is empirically supported by curious exceptions to Principle C reported on by Fiengo & May (1994:265), and Fox (1995), illustrated in (24), using conventional indexing:

(24) I bought him_i everything John_i wanted me to

In (24), the basic obviation required by the R-expression *John* is lifted without loss of grammaticality. (24) contrasts with the expected Principle C violation (25):

(25) * I bought him_i everything John_i wanted

The contrast between (24) and (25) obviously corresponds with the presence vs. absence of 'verb phrase ellipsis', (24) being interpreted as (26):

(26) I bought him_i everything John_i wanted me to buy him_i

The standard analysis of VP-ellipsis since Williams (1977) involves generation of an empty VP at D-structure and reconstruction of the contents of that VP on the basis of an 'antecedent' VP at LF. Under this analysis of VP-ellipsis, the absence of a Principle C violation is unaccounted for.¹²

As argued by VandenWyngaerd and Zwart (1998), the standard analysis of VP-ellipsis is not easily reproduced within the minimalist approach.

The standard analysis relies crucially on a top-down structure building process involving context free rewrite rules, and on a distinction between structure building and lexical insertion. As a result, empty structure can be generated by the rewrite rules (such as an empty VP¹³) but ignored in the lexical insertion process. In this approach, LF operations (like reconstruction) are indispensable to ensure the correct interpretation of the empty structure.

In the minimalist approach, no such distinction between structure building and lexical insertion is made. As a result, empty structure has to be produced by merging empty elements, or, alternatively, no empty structure is generated and ellipsis results from deletion (i.e. non spell out) of duplicated material at PF.

The PF deletion approach is undoubtedly more attractive from the minimalist point of view. It is also supported by Tancredi's (1992) observation that VP-ellipsis is semantically indistinguishable from VP-deaccenting, suggesting that ellipsis is just an extreme form of deaccenting.

By consequence, we may assume that constructions like (24) involve a full VP *buy him* in the most deeply embedded clause right from the start of the derivation. Applying the derivational theory of binding now yields a stage where the indexing is as in (27):

(27) everything John₂ wanted me to buy [him₁]₂

Anticipating the discussion of how indices are assigned in ellipsis contexts, it is clear that the derivation of (24) cannot treat the next instantiation of *him* as independent of the *him* already present in the structure. So let us assume that in precisely these contexts, the principle that every noun phrase receives an independent index is lifted (independently of the presence of an intervening R-expression like *John* in (27)). The indexing of (24) will then come out as in (28):

(28) I bought [him₁]₂ everything John₂ wanted me to buy [him₁]₂

The bottom-up structure building procedure in effect makes the elliptical VP the 'antecedent' for the overt VP, a reversal of traditional terminology.¹⁴ It is precisely the 'antecedence' of the elliptical VP that makes lifting the obviation requirement possible.

On these assumptions, the existence of constructions like (24), where Principle C is scorned, presents clear empirical support for the derivational theory of binding under investigation in this paper. A representational theory

of binding, where reference is tracked in a top-down fashion (mostly tacitly), could not account for the dependence of the anti-obviation on the ellipical VP.¹⁵

8. Some Further Issues.

8.1 Superraising

Lasnik (1985) discusses locality conditions on A-movement in the light of examples like (29):

(29) * John_i seems that [_D he_i likes t_i]

In (29), *John* is raised out of the embedded clause and binds the pronoun *he* from its derived position. The trace of *John* is now coindexed with a c-commanding antecedent, and is by sheer coincidence bound within the local domain D. Since A-movement traces are regarded as anaphors in that they must be locally bound (Chomsky 1982:20), the ungrammaticality of (29) is unexplained.¹⁶

Lasnik (1985) and Lasnik & Saito (1992:133f) propose to describe locality conditions on A-movement not in terms of the principles of the Binding Theory, but in terms of locality conditions on chain links. This approach is essentially also adopted in Rizzi (1991), in terms of ‘relativized minimality’, and Chomsky (1995:181), in terms of a ‘shortest move’ requirement.

From the present perspective, the argument based on examples like (29) lacks force. The obviation principle C requires *he* in (29) to be contraindexed to *John* at the moment of its merger to the structure, so that assignment of the index of *John* as the outer index of *he* yields an uninterpretable object of the type of (16).

Importantly, the strict locality condition on A-movement entailed by the ‘shortest move’ requirement of Chomsky (1995:181) follows straightforwardly from the strictest version of Principle A of the Binding Theory as reformulated here. If the outer index of an anaphor must be assigned by the next noun phrase merged to the structure, and if NP-traces are anaphors, it follows that no noun phrase can intervene between the anaphor/NP-trace and its antecedent.^{17,18}

8.2 Reconstruction

Barss (1986) discusses examples like (30), where *himself* is bound by either *John* or *Bill*:

- (30) a. Which pictures of himself does John think that Bill really likes?
b. John wonders which pictures of himself Bill really likes

Apparently, *himself* can ‘pick up’ an antecedent in its basic position to the right of *likes* as well as in the derived position where we see it in (30b). Binding of *himself* by *John* in (30a) then follows if *which pictures of himself* has moved through that derived position on its way to the left periphery of the sentence. Interpretation of *himself* through a position formerly occupied by it in the course of the derivation is referred to as *reconstruction* (not to be confused with reconstruction of the contents of an empty VP at LF, cf. section 7).

The interpretation of the sentences in (30) where *himself* is bound by *John* is problematic for the derivational approach to binding under scrutiny here. The outer index of *himself* should be equated with the index of the first noun phrase merged to the structure, *Bill*, at all times.

Importantly, *himself* in ‘picture noun contexts’ poses more problems for the Binding Theory (cf. Postal 1971:188). For example, in (31), *himself* is exceptionally bound from outside the local domain D:

- (31) John_i said that [_D [several pictures of himself_i] would be on sale]

The Dutch anaphor *zichzelf* behaves differently, not only when compared to (31), but also when compared to (30):

- (32) * Jan_i zei dat [_D [verschillende foto’s van zichzelf_i]
John said that several pictures of himself
te koop waren]
for sale were

- (33) a. * Welke foto’s van zichzelf_i zei Jan_i dat
which pictures of himself said John that Pete
leuk vond ?
nice found

- b. * Jan_i vroeg zich af welke foto’s van zichzelf_i Piet
John wondered which pictures of himself Pete
leuk vond
nice found

Zichzelf behaves as predicted by the derivational theory of binding: it can only be bound by the first noun phrase merged to the structure containing it (*Piet* in (33)), and it must be bound within domain D (illustrated by (32)).

Outside of picture noun contexts, *himself* behaves as expected (Barss 1986:156):

- (34) a. * John_i wondered why himself_i, Mary didn't like
 b. * John_i wondered how proud of himself_i Mary really was
 c. * John_i thinks that a critic of himself_i, Mary became

This suggests that something special is going on with *himself* embedded in nonpredicative noun phrases. Since the same effect does not show up with unsuspected anaphors like Dutch *zichzelf*, it has been assumed that *himself* in English is in fact ambiguously a true anaphor and a logophor (a long-distance, subject-oriented pronominal, Dutch *'mzelf*)(cf. Koster 1985). The long-distance binding facts in picture noun contexts would involve logophoric *himself*.

If so, we may maintain the strong claim that anaphors may never pick up an antecedent from a derived position. This in turn is strong evidence in support of the theory of binding investigated here, where binding relations are determined once and for all in conjunction with the operation Merge.

8.3 Strict and Sloppy Identity

A question arises as to how strict and sloppy identity may be described in the system outlined here.

Strict and sloppy identity can be illustrated through the two interpretations in (36) of the example in (35):

- (35) John thinks he is a genius, and so does Bill <think he is a genius>
- (36) a. John thinks *John* is a genius, and Bill thinks *John* is a genius
 b. John thinks *John* is a genius, and Bill thinks *Bill* is a genius

(36a) is the strict reading of (35), (36b) the sloppy reading.

Since constructions involving strict/sloppy ambiguity invariably involve ellipsis, we must assume (following the discussion in section 7), that the elliptic material is present from the start of the derivation. It is indicated in angled brackets in (35).

A sloppy reading is forced when the dependent element (the pronominal) is an anaphor:¹⁹

- (37) John loves himself, and so does Bill <love himself>

This follows from Principle A, stating that the outer index of an anaphor must be determined by a newly merged noun phrase within domain D (section 6.3). In (37), the only potential antecedent for the occurrence of *himself* in the elliptical part is *Bill*, precluding the strict interpretation where *himself* is bound by *John*.

Pronouns differ from anaphors in that they do not *require* the outer index to be determined on the basis of another noun phrase merged to the projection containing the pronoun. Thus, whereas (38) is perfectly acceptable, with the pronoun *he* adopting the outer index of *Bill*, *he* is free to refer to a noun phrase that is not merged to a projection containing *he* (39a), or even to a person known through the discourse only (39b):

- (38) Bill₂ says [_D [he₁]₂ knows John well]
 (39) a. [Bill₂'s mother] says [_D [he₁]₂ knows John well]
 b. (*pointing at Bill₂*) [_D [He₁]₂ knows John well]

Let us refer to this inherent ambiguity in pronouns by saying that the outer index of a pronoun is either *relative* (i.e. determined on the basis of Merge, as in (38)), or *absolute* (i.e. determined through other means, as in (39)).²⁰ It is easy to see that an absolute outer index precludes a sloppy identity interpretation.

(40) repeats the strict/sloppy identity pattern of (35) with the relative/absolute status of the outer indices marked:

- (40) a. John thinks [he]_{ABS} is a genius, and so does Bill <think [he]_{ABS} is a genius>
 b. John thinks [he]_{REL} is a genius, and so does Bill <think [he]_{REL} is a genius>

As before, the occurrence of *he* in the first conjunct is an exact match of the occurrence of *he* in the elliptical second conjunct. The inherent ambiguity of pronouns (as either relative or absolute) automatically derives the strict (40a) and sloppy (40b) interpretation of these sentences. In (40a), the pronoun has some fixed reference, indicated by the absolute character of the outer index, which is the same for both occurrences of the pronoun.²¹ In (40b), the outer index of each occurrence of the pronoun must be determined on the basis of a newly merged noun phrase, yielding different interpretations for each occurrence of the pronoun (i.e., a sloppy reading).²²

This much is automatic and fully understandable assuming the bottom-up reference tracking procedure under investigation here. As soon as a pronoun is merged to the structure, a decision is made as to the relative or absolute status of its outer index. If relative, the pronoun behaves like a nonlocal anaphor, and we obtain a sloppy interpretation under coordination and ellipsis. If absolute, the outer index must remain constant under coordination and

ellipsis (regardless the mechanism by which it is ultimately determined), yielding a strict interpretation.

8.4 A Remaining Problem

The reference tracking procedure discussed here is unable to account for the following contrast:²³

- (41) a. Which report that *John* revised did *he* submit?
b. * Which report that *John* was incompetent did *he* submit?

Assuming that the sentences in (41) derive from the partial representations in (42), *he* must be understood as having an outer index that is complementary to the index of *John*:

- (42) a. [he_2]₋₁ did submit which report that $John_1$ revised
b. [he_2]₋₁ did submit which report that $John_1$ was incompetent

Consequently, the coreference indicated in (41a) could never be obtained.

There is no immediate way out of this problem.²⁴ Possibly the premiss that the sentences in (41) are derived from the representations in (42) is false. An informal suggestion would be that (41a), for example, is interpreted analogously to (43):

- (43) Which report that *John* revised is the one that *he* submitted?

The mechanism by which this interpretation might come about is unclear, however.

9. Conclusion

The reference tracking procedure proposed in this paper has the following properties.

Indices are assigned as soon as an element is merged to the structure. A binding relation between α and δ is established as soon as α is merged to β containing δ . The elements that can be so bound are *variable referential elements*: pronouns and anaphors. The referential properties of these elements are indicated by a combination of inner and outer indices, the latter to be determined by the antecedent (or also, in the case of pronouns, through other means not discussed here).

Principle C of the binding theory follows from the default indexing procedure, which requires that every newly merged element takes a different index. More precisely, the outer index of every newly merged noun phrase c-commanding an R-expression is biased to be complementary to the index of the R-expression. As a result, movement of the R-expression cannot lift

obviation. Obviation can only be lifted if the interpretation of the element c-commanding the noun phrase is derived from another noun phrase c-commanded by the R-expression, as in the parallel construction *I gave him everything John wanted me to (give him)*.

Anaphors differ from pronouns in the familiar different locality conditions on binding. In addition, pronouns have the inherent property of allowing reference to be fixed through other means than binding (a type of index assignment we refer to as *absolute*). Once the difference between relative and absolute index assignment is recognized, the possibility of having sloppy and strict interpretations of pronouns under ellipsis follows automatically, assuming the bottom up reference tracking procedure discussed in this paper (in combination with a PF-deletion analysis of ellipsis).

Other constructions where principle C is lifted as a consequence of movement (as in *Which paper that John revised did he submit?*) remain problematic under the reference tracking approach discussed here.

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Notes

1. The idea of describing binding as a function of Merge was brought to my attention by Lily Schürcks (see Schürcks 1998).
2. α c-commands β iff β is dominated by the minimal projection dominating α , and $\alpha \neq \beta$.
3. The classical definition of binding apparently aims to establish a subset of coreference relations, namely the set of coreference relations involving c-command. Binding can then be further divided into *anaphor binding* (which is local w.r.t.

domain D and involves anaphors, reciprocals and reflexives) and *bound variable binding* (which is nonlocal w.r.t. domain D and involves pronominals—often called ‘anaphora’ in the semantic literature).

4. Chomsky’s (1995:193, 205) approach to examples like (7), showing that the binding principles apply prior to LF, involves a) adoption of a *copy* theory of movement (the trace being a copy of the moved category) and b) an LF-operation which selectively deletes different parts of the two copies (i.e. the moved category and its trace). In (7), for example, the approach yields that we cannot exclude that *John* is still present in the position of the trace at LF, voiding the argument.
5. A familiar problem regarding the status of noun phrases as anaphors or pronominals is that not all languages make a morphological distinction between the two (e.g. Frisian, Old English). If these elements are defined as [+anaphoric, +pronominal] in C_{HL} , the LF interpretation principles would not know how to interpret them. This problem disappears if ‘words’ in C_{HL} are just bundles of syntactic and semantic features, which acquire their phonological features only in the morphological component at PF (Aronoff 1992, Halle & Marantz 1993, Zwart 1997b). The LF interpretation procedure is only sensitive to the bundles of syntactic and semantic features, which differ in the cases of anaphors and pronouns, even if these two bundles of features receive the same spell out in certain languages, by morphological accident.
6. Another basic condition may be that merge involves two and only two terms (ensuring binary branching and precluding vacuous structure).
7. I intend ‘reference’ to be understood as the representation of an individual concept, not as reference to a real world entity.
8. In the notation of Tancredi (1992), apparently following Heim (1992), the dependent element in a binding relation bears only an inner index, whereas the antecedent bears an inner index and an outer index. In the notation employed here, only dependent elements bear an inner index and an outer index.
9. The question of whether anaphors are bound by the first noun phrase up or by any noun phrase within the local domain D hinges on the status of examples like (i):

- (i) a. ? Jan hoorde ons zichzelf een oplichter noemen
 John heard us himself a crook call
 b. Jan raadde ons zichzelf aan
 John suggested us himself PRT

In (ib), binding of *zichzelf* by *Jan* is unproblematic, but examples of this type may be irrelevant, when the indirect object is in fact a PP. In (ia), binding of *zichzelf* by *Jan* is curiously degraded (but significantly better than alternatives with *him*, *zich*, or *'mzelf*). There may be confusion with constructions like (ii), where the infinitive is passive and *zichzelf* is the derived subject of the infinitival clause:

- (ii) Jan hoorde zichzelf een oplichter noemen
 John heard himself a crook call

The contrast between (ia) and (ii) suggests that there is a 'minimality' factor in addition to the locality factor.

10. Various proposals have been made to allow extension of the local domain relevant to anaphor binding beyond the maximal projection of a tensed embedded clause, in view of examples like (i):

(i) *John* saw that [[pictures of *himself*] were on sale]

I follow Koster (1985:142) in assuming that *himself* is not a genuine anaphor here, since the Dutch translation of (i) does not employ the genuine anaphor *zichzelf*, but the 'logophoric' element *'mzelf*.

11. Similar considerations apply if locality is not determined by an opacity factor but by an element of 'completion', as in the approach based on a complete functional complex (Chomsky 1986), or a complete licensing domain (Zwart 1997a).
12. Fiengo & May's (1994) analysis describes (24) as an exception to the rule that Principle C applies at S-structure (that rule is needed to explain that QR does not obviate Principle C in examples like (i) **I bought him_i everything John_i likes*). (24) then follows because QR takes the R-expression out of the scope of its binder. Fox's (1995) analysis modifies Fiengo & May's (1994) analysis, proposing that material from the copy left behind by QR is deleted when deletion is forced by interpretability requirements (for example to overcome the infinite regress in antecedent contained deletion contexts like (24), but crucially not in other constructions involving QR, like (i)).
13. Even an empty VP with a full fledged structure, as Williams (1977) assumes following Wasow (1972).
14. The traditional terminology, of course, is hopelessly confused. Constructions like (24) are indicated as 'antecedent contained deletion', while being analyzed in terms of reconstruction rather than deletion. 'Gap containing reconstruction' would be a term that describes the current standard analysis more appropriately and makes the concomitant 'infinite regress' more understandable.
15. Of course if the LF interpretation procedure were to operate in a bottom-up fashion, after reconstruction, the interpretation procedure would merely mirror the derivational procedure, and the question would be justified if it could not be dispensed with.
16. Chomsky (1986:197f) argues that (29) is ungrammatical because the chain (*John*, *t*) is Case-marked twice (violating the Chain Condition). Lasnik and Saito (1992:139) provide the example in (i) as making the same point as (29) without violating the Chain Condition:

(i) * *John_i seems that [_D his_i belief *t_i* to be rich] is wrong*

17. As with binding, it is not always clear that A-movement obeys the strictest version of locality referred to in the text (cf. note 9). Thus, examples like (i) may involve nonlocal A-movement across the direct object:

- (i) [Het boek]_i werd Jan t_i overhandigd
 the book was John handed-over
 'The book was handed over to John.'

Ura (1994) presents a host of cases where A-movement takes place across the opacity factors 'tense' and 'subject'. As far as I have been able to assess, these cases do not unambiguously support the analysis proposed by Ura (cf. Zwart 1997c).

18. It is not clear to me how the idea that NP-traces are anaphors carries over in the present framework. If anaphors are defined as [+referential, +variable] elements that must have their reference fixed locally, the only point of similarity appears to be the locality factor. NP-trace, if regarded as a copy of the moved category (cf. Chomsky 1995:210), must be [+referential, -variable] and presumably does not need to have its reference fixed. The question is obscured by the circumstance that traces are really subparts of discontinuous categories (chains). One possibility would be to interpret the tail of a chain as a [-referential, +variable] element, i.e. as a zero variant of anaphors and pronouns, which then, by analogy with anaphors and pronouns, could divide naturally into locally identified traces (A-traces) and nonlocally identified traces (A'-traces). This would entail that A'-traces are not R-expressions but pronouns (for the principles of the Binding Theory).

19. The elliptical construction in (i) does seem to allow a strict interpretation, where Bill loves John. However, it is a known fact that ellipsis applies to cases where strict morphological identity of the noun phrases involved is not observed (Bouton 1970; this fact is captured in reconstruction based approaches by a mechanism of *vehicle change*, cf. Fiengo and May 1994:218, VandenWyngaerd and Zwart 1991). Thus (i) may, and in the strict reading must, be derived from (ii) rather than from (iii):

- (i) John loves himself and Bill does, too.
 (ii) John loves himself and Bill does <love him> too.
 (iii) John loves himself and Bill does <love himself> too.

Note that reciprocals do not allow a strict reading (iv), presumably because the more complex semantics of reciprocals does not allow for variation (i.e. replacement by an ordinary pronoun) in deaccenting and ellipsis contexts:

- (iv) John and Mary love each other, and so do Bill and Sue <love each other/*them>

In (iv), *them* is not a suitable counterpart to *each other* because the situation of Bill and Sue loving John and Mary does not parallel the situation of John loving Mary and Mary loving John.

20. I presume that this is the same contrast in indexical type that Fiengo and May (1994:47) capture using α - and β -occurrences of indices.

21. Importantly, the two occurrences of the pronoun cannot have two *different* absolute outer indices, e.g. yielding the interpretation *John thinks he (Harry) is a genius and so does Bill think he (Peter) is a genius*.
22. It follows that c-command is a precondition for sloppy interpretation of a deaccented or elliptical pronoun, a well-known fact.
23. The discussion in Lasnik (1998) suggests that the contrast in (40) is artificial, and that both sentences may be judged felicitous under the right circumstances. This only aggravates the problem noted in the text.
24. Chomsky (1995:204), following the analysis in Lebeaux (1990), proposes that the relative clause in (41a) is merged 'countercyclically', i.e. after the pronoun has been merged to the structure. This would solve the problem, but not if the discussion in Lasnik (1998) referred to in note 23 is correct.