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Pronouns and Bound Variables*

1. The Problem

Suppose that Σ is a surface structure, A is an occurrence of a quantificational NP in Σ, and B is an occurrence of a pronoun in Σ. Under what circumstances can the pronoun be interpreted as a variable, bound to the quantificational NP? Our analysis has for its target sentences such as (1):

(1) Everyone here thinks he's a nice fellow.

(1) admits both a *deictic* interpretation, in which the pronoun *he* functions as purporting to refer to some individual, and a *bound* interpretation, in which it functions as a variable controlled by the quantificational subject, *everyone here.*[1]

In (1) and in the other examples given in this article, the bound interpretation of the pronoun is optional. We exclude, for reasons given below, the case in which B is reflexive or reciprocal. We also exclude the case of ordinary pronouns which must be interpreted as bound anaphora in certain constructions; for instance, the *him* of (2):

(2) Someone brought a knife with him.

In (2), *him* must be interpreted as a bound variable. Similarly, it must be interpreted as coreferential with *John* in (3):

(3) John brought a knife with him.

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[1] The distinction between deictic and bound interpretations may be drawn independently of the question of quantification into opaque contexts. Merely for the sake of expository brevity and uniformity of notation, I will speak in this article as though quantification past the opacity-making verb *thinks* and the like were possible. But the analysis can be translated into other frameworks, e.g. those of Quine (1956) or Kaplan (1969).

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An appropriate account of (3) will imply as a special case the necessity of the bound interpretation of *him* in (2).

Presupposed here will be the general form of the theory of Chomsky (1980), and the rule QR of quantifier construal given in May (1977). In the next section and the remainder of this one, we will consider in light of these works, and others to be cited, some preliminary suggestions toward solving the central problem of this article; these suggestions will be modified and extended as we proceed. In conclusion, the extended analysis will be applied to a number of special cases.

The general organization of syntax is taken to be (4),

(4) DS _____ SS _____ LF

where DS is deep structure, SS is surface structure, and LF is logical form; see Chomsky (1976). May's QR is among the rules of grammar mapping from SS to LF. QR assigns scopes to quantificational NPs by Chomsky-adjoining them to the node S, leaving trace.[2] The notion of *scope* is so defined that the scope of an NP adjoined by QR is the S to which adjunction takes place. The trace of QR is interpreted as a variable; it is bound to the quantifier if within its scope.

The effect of QR on the surface structure (5) is (6),

(5) $[_S[_{NP}$ someone here] is nice]

(6) $[_S[_{NP}$ someone here]$_i$ $[_S$ e_i is nice]]

where e_i is the trace, coindexed with the moved element. The *scope* of a constituent is what it *c*-commands.[3] In (6), e_i is within the scope of the quantifier, and is therefore properly bound by it.

Suppose that the status of *him* in (3) above is expressed by some rule of bound-anaphora, obligatorily coindexing this pronoun with its antecedent, the subject *John*. Suppose further that the bound-anaphora rule coindexes *someone* and *him* in (2). Then after QR applies we shall obtain from (2) the structure (7):

(7) $[_S[_{NP}$ someone]$_i$ $[_S$ e_i brought a knife with him$_i$]]

Making the natural assumption that a pronoun coindexed with a variable is itself a variable, we can let (7) be the proper LF representation of the surface structure of (2). Note that both the pronoun and the trace of QR are within the scope of the quantifier.

Proceeding by analogy with (2) to the target cases of this article, we might propose that an occurrence B of a pronoun will be interpreted as a variable bound to $A = NP_i$, A quantificational, iff (i) B can be coindexed with A at LF, and (ii) at LF, B is within the scope of A. For the bound interpretation of (1) we would propose the representation (8):

(8) $[_S[_{NP}$ everyone here]$_i$ $[_S$ e_i thinks he$_i$'s a nice fellow]]

For the deictic interpretation we would propose (9), with $i \neq j$.

(9) $[_S[_{NP}$ everyone here]$_i$ $[_S$ e_i thinks he$_j$'s a nice fellow]]

Following Chomsky (1980), we will assume a condition on surface structures that we will express informally as (10):

(10) Every *anaphor* (i.e. element requiring an antecedent) must be coindexed at SS with an element that *c*-commands it.

With QR as the rule of quantifier construal, (10) already solves the problem of this article for the case where the pronoun B is an anaphor; for if B is an anaphor, it may already be coindexed at SS with any quantificational antecedent that it may have.

2. Indexing

In this section we will outline the relevant parts of the analysis of Chomsky (1980), and consider further the hypothesis that (1) may have at LF both representations like (8) and representations like (9). In Chomsky (1980), there are two *distinct* mechanisms of NP indexing. The first is *coindexing*, which relates anaphoric elements to their antecedents. The other might be called *contraindexing*; this mechanism relates pairs of elements at least one of which is not anaphoric.

Considering for the moment only the simplest case, that of singular referential NPs, we may bring out the intended interpretations of the application of these two mechanisms as follows. If A, B can be coindexed in a surface structure Σ, then they can be purported to be coreferential; if they must be coindexed, then they must be so purported. If A, B are contraindexed in Σ, then they cannot be purported to be coreferential; otherwise, they can.[4] In the simplest examples, (11) and (12),

(11) John saw himself.

(12) John saw him.

the coindexing mechanism will ensure that *John* and *himself* bear the same index, and the contraindexing mechanism will ensure that *John* and *him* in (12) are contraindexed.

In Chomsky (1980), it is assumed that every NP will be assigned some index or other, called its *referential index*.[5] Coindexing A and B then means assigning them the

[2] See Fiengo and Higginbotham (1979) and Higginbotham (in preparation) for proposed extensions of QR.

[3] By definition, X c-*commands* Y iff neither of X, Y dominates the other, and the first branching node dominating X dominates Y; see Reinhart (1979). It should be noted that the definition of scope in terms of *c*-command is, by means of some auxiliary apparatus, interdefinable with the more traditional conception of Russell; for details, see Higginbotham (in preparation).

[4] The contraindexing in Chomsky (1980) is a further development of ideas suggested in Lasnik (1976), who in turn notes their affinity to Lakoff (1968). My interpretation of contraindexing differs from Lasnik's, for reasons given in Higginbotham (1980), footnote 1.

[5] The term "referential" here must not be taken literally, because referential indices attach to all NPs indiscriminately, regardless of their semantic role. The precise interpretation of coindexing will vary, depending on the constructions involved.

same referential index. Contraindexing works by assigning to nonanaphoric NPs (i.e. those not requiring antecedents) *anaphoric indices*. An anaphoric index is a set of referential indices. The intended interpretation of this device for the simplest case is (13):

(13) NP_i, NP_j cannot be purported to be coreferential if the referential index of either is an element of the anaphoric index of the other.

In the case of plurals, "coreferential" in (13) may be replaced by "overlapping in reference".

Every nonanaphor is doubly indexed, bearing both a referential and an anaphoric index. The initial principle governing the assignment of anaphoric indices is (14):

(14) Assign to the anaphoric index of NP_i the set of all referential indices of NPs that *c*-command NP_i, if NP_i is not an anaphor.

Consider again the simple example (12), repeated here,

(12) John saw him.

and assume that the subject NP *John* *c*-commands the pronoun *him*, though not conversely. Indexing will yield (15):

(15) $John_{i,\phi}$ saw $him_{j,\{i\}}$.

The anaphoric index of *John* is empty, since nothing *c*-commands it. But the anaphoric index of *him* = $\{i\}$ contains the referential index of the *c*-commanding *John*. Applying (13) we have, correctly, that (12) cannot constitute an assertion that John saw himself.

Now consider (16):

(16) John thinks he's a nice fellow.

The items *John*, *he* should not be contraindexed, for purported coreference between them is possible. Applying (14), we shall index (16) in the pertinent respects as (17), with $i \neq j$.

(17) $John_i$ thinks $he_{j,\{i\}}$'s a nice fellow.

For this and similar cases, Chomsky in (1980) has proposed that rules of grammar may delete some referential indices from the anaphoric indices of pronouns, thus permitting purported coreference. To state the rule, we require a few definitions. A pronoun *B* is *free(i)* in *X* iff it occurs in *X* and there is nothing in *X* with referential index *i* that *c*-commands *B*. *B* is *nominative* if governed by tense, and *in the domain of the subject of* *X* if *X* has a subject *Y* that *c*-commands *B*. If $X = \bar{S}$ or NP, *X* is *minimal* if it contains *B* and every $Y = \bar{S}$ or NP that contains *B* contains *X*. Now we may state (18):

(18) If *B* is a pronoun that is free(*i*) in the minimal $X = \bar{S}$ or NP containing *B*, and *B* is either:

(a) nominative; or,
(b) in the domain of the subject of *X*,
then *i* deletes from its anaphoric index.[6]

The clause (a) in (18) is the *Nominative Island Condition* (NIC); the clause (b) is the *Opacity Condition* (OC). Now, (17) will have the structure (19):

(19) [$_S$ $John_i$ thinks [$_{\bar{S}}$ $he_{j,\{i\}}$'s a nice fellow]]

Hence the NIC applies, and *i* deletes from the anaphoric index of the pronoun. For an example of OC, consider (20):

(20) $John_i$ wants [$_{\bar{S}}$ Mary to visit him]

The pronoun *him* will be free(*i*) in $\bar{S}$, and in the domain of the subject *Mary*. So the OC applies, and purported coreference between *him* and *John* is permitted. In the simple case (12) above, repeated with indices in place as (21),

(21) [$_{\bar{S}}$ $John_i$ saw $him_{j,\{i\}}$]

the pronoun is not free(*i*) in $\bar{S}$, and neither the NIC nor the OC applies. In (22),

(22) $John_i$ wants [$_{\bar{S}}$ $him_{j,\{i\}}$ to win]]

him_j is free(*i*) in $\bar{S}$; but it is not nominative, since $\bar{S}$ is infinitival, nor in the domain of the subject, since it is the subject. So again neither the NIC nor the OC applies; a correct result in this case, because (22) cannot be used as purporting coreference between *John* and *him*.

This concludes our brief outline of the principles governing the algorithm presented in the appendix to Chomsky (1980) (hereafter: the Indexing Algorithm), and the relevant details of its operation. We return now to the problem of pronominal binding. Consider again the example (1):

(1) Everyone here thinks he's a nice fellow.

(1) will be indexed in the relevant respects as (23):

(23) [$_S$[$_{NP}$ everyone here]$_2$ thinks [$_{\bar{S}}$ $he_{3,\{2\}}$'s a nice fellow]]

By the NIC, 2 deletes from the anaphoric index of he_3. But the pronoun cannot share a referential index with the subject NP *everyone here*. Suppose, however, that there were some reindexing rule, optionally changing the indices of nonanaphoric pronouns, where this rule, like QR, relates SS to LF. If this rule affects he_3 in (23), changing it to he_2, then following the application of QR we will obtain from (23) the structure (24):

(24) [$_S$[$_{NP}$ everyone here]$_2$ [$_S$ e_2 thinks he_2's a nice fellow]]

In (24), he_2 will be interpreted as a bound variable.

[6] (18) is a special case of the more general rule of Chomsky (1980).

In the next two sections, we will make more precise the form of the reindexing operation just suggested.[7]

3. Coreference and Binding

As we have seen, the Indexing Algorithm provides a partial answer to the question of when referential overlap between referential NPs is permitted by the rules of sentence grammar. But referential overlap will be permitted between positions *A* and *B* where binding of *B* by *A* will not be possible, because binding must take quantifier scope into account. Contrast (25) and (26):

(25) Somebody who liked *John* lent *him* money.
(26) *Somebody who liked *everybody* lent *him* money.

(Above and hereafter, the italicization invites the reader to consider the coreferential interpretation (as in (25)) or the bound interpretation (as in (26)); a * expresses the judgment that the indicated interpretation is not available.) The Indexing Algorithm predicts that purported coreference should be possible between *John* and *him* in (25), because neither of these NPs *c*-commands the other. But binding is impossible in (26) because the embedded quantifier cannot escape its surface clause, and so will fail at LF to *c*-command the pronoun.

A general observation, which any adequate theory of pronominal binding must imply, is that a pronoun can be bound to a quantificational NP only if it could overlap in reference with a referential NP occupying the same position as the quantifier. Possibilities for binding form a subset of possibilities for overlapping reference—a proper subset, as (25)-(26) show. For some simple examples, consider (27)-(30):

(27) He expected to see him.
(28) He expected Bill to see him.
(29) Someone expected to see him.
(30) Someone expected Bill to see him.

(27) cannot be used as purporting coreference between *he* and *him*; but (28) can. Similarly, *him* cannot be bound to the subject *someone* in (29), but is bindable in (30). Suppose for this exposition that the Equi in (27) and (29) is *self*-deletion; then to the surface structure of (27) the Indexing Algorithm assigns indices as shown in (31):

(31) he_2 expected [$_{\bar{S}}$ for e_2 self to see $him_{3,\{2\}}$]

Indexing of (28) gives (32):

[7] No bound variables are actually visible in (24), which is assumed to yield eventually what we may represent by (i),

(i) [every x: x is a person here] x thinks x is a nice fellow

where [*every x: x is a person here*] is a restricted quantifier. In general, representations such as (i) are eschewed here, because their derivation requires further elaboration of rules, on which no issues in the present discussion appear to depend. These representations are used occasionally below, where it seemed that intended interpretations could be given more transparently thereby.

(32) he_2 expected [$_{\bar{S}}$ $Bill_{3,\{2\}}$ to see $him_{4,\{2,3\}}$]

By the OC, 2 deletes from the anaphoric index of *him* $_4$ in (32). But in (31), *him* $_3$ is not free(2) in $\bar{S}$, and so 2 does not delete from its anaphoric index. Since 2 is the referential index of *he* $_2$, these positions cannot purport to be coreferential. By exactly the same reasoning, in (29) but not in (30) the referential index of the quantifier *someone* will be an element of the anaphoric index of the pronoun *him*, presumably making binding impossible in (29). Generalizing, we might say that we cannot bind a pronoun *B* to quantificational NP *A* if the referential index of either is an element of the anaphoric index of the other; that is, if *A*, *B* are contraindexed.

Now consider (33):

(33) Everyone told someone he expected to see him.

On the class of interpretations with *everyone* taking wide scope, (33) is seven ways ambiguous: we can bind either pronoun to either quantifier, or bind neither, etc. But we cannot bind both pronouns to the same quantifier. For instance, (33) cannot be interpreted as meaning that everyone is an x such that x told someone that x expected to see x. We see, therefore, that the generalization of the last paragraph requires supplementation.

Suppose now that the reindexing rule for pronouns were subject to the condition (34):

(34) For all *i*, *j*, if $pronoun_j$ reindexes as $pronoun_i$, then every occurrence of *j* in the structure to which reindexing applies is to be replaced by an occurrence of *i*.

The principle (34) ensures that when a pronoun is bound to a quantificational NP, then every anaphor of which it is the antecedent is bound as well. Thus, in (35),

(35) Someone forgot he brought a knife with him.

either both or neither of *he, him* are bound variables. By (34), it is impossible to reindex either without reindexing the other.

To see the effect of (34) in conjunction with the Indexing Algorithm, first consider (36):

(36) Someone saw him.

Assignment of indices to the surface structure of (36) gives (37),

(37) $someone_2$ saw $him_{3,\{2\}}$

with *him* $_3$ not free(2) in S (and so not free(2) in $\bar{S}$). If *him* $_3$ reindexes to *him* $_2$, either before or after QR has applied in (37), we shall obtain at LF (38):

(38) [$_S$ $someone_2$ [$_S$ e_2 saw $him_{2,\{2\}}$]]

The pronoun then has its own referential index contained in its anaphoric index. But, as Robert May first pointed out in (1979), in conjunction with his analysis of certain cases of misgeneration due to movement, we have good reason for regarding (38) as

semantically absurd. Recalling the understood significance of assignments of referential and anaphoric indices, it is natural to interpret the position marked by *him* $_{2,\{2\}}$ as instantiatable only to objects that are distinct from themselves; therefore, to no objects at all.

We return to the case of (33), repeated here:

(33) Everyone told someone he expected to see him.

Initial assignment of indices to (33) gives (39):

(39) everyone$_2$ told someone$_{3,\{2\}}$ [$_{\bar{S}}$ he$_{4,\{2,3\}}$ expected [$_{\bar{S}}$ for e$_4$ self to see him$_{5,\{2,3,4\}}$]]

The NIC and OC now apply, deleting 2 and 3 from the anaphoric indices of both pronouns. But 4 will not delete from the anaphoric index of *him* $_5$, because this pronoun is *c*-commanded in the minimal $\bar{S}$ by an anaphor controlled by e_4. Given the result (40) of carrying out the indicated deletions in (39),

(40) everyone$_2$ told someone$_{3,\{2\}}$ [$_{\bar{S}}$ he$_4$ expected [$_{\bar{S}}$ for e$_4$ self to see him$_{5,\{4\}}$]]

consider what will happen if we attempt through reindexing, subject to (34), to bind both pronouns to the same quantifier, say *everyone* $_2$. *he* $_4$ and *him* $_5$ must both reindex to 2, and so by (34) the anaphoric index of the latter will contain 2. Since further reindexing cannot change this situation, the only possible derived structures will have the form (41):

(41) . . . he$_2$ expected . . . him$_{2,\{2\}}$

These structures will be "strange" at LF, just as (38) is. Henceforth, we assume (34) as a condition on reindexing.[8]

4. Directional Asymmetries

We have seen that if reindexing is coupled with the convention (34), then we have the correct consequence that possibilities for binding are constrained by possibilities for coreference, or overlapping reference. We turn now to cases where binding is impossible due to "crossover". Consider (42)–(44):

(42) His father hates John.
(43) His father hates someone.
(44) Who does his father hate?

Purported coreference between *his* and *John* is possible in (42), but pronominal binding is impossible in both (43) and (44). (43) cannot be interpreted as asserting that someone is an x such that x's father hates x; neither can (44) be interpreted as a general question, asking which person is an x such that x's father hates x. We saw earlier that the possibility of coreference did not always imply the possibility of binding, because of considerations on scope; but these considerations are of no avail above. Why, then, is binding impossible?

Chomsky (1976) proposed a distinction between possibilities for binding and possibilities for coreference which he expressed initially as (45):

(45) A variable cannot be the antecedent of a pronoun to its left.

I will call (45) the *Leftness Condition*. Applied to (46), derived from (43), or to (47), derived from (44), the Leftness Condition correctly predicts that the pronoun cannot be bound, since its "antecedent"—the variable x—occurs to its right at LF.

(46) [for some x: x is a person] his father hates x
(47) [for which x: x is a person] his father hates x

Now consider (48):

(48) Some musician will play every piece you want him to.

him can be bound to *some musician*. The bound interpretation of (48) would be given at LF by (49):

(49) [some x: x is a musician] [every y: y is a piece you want him (= x) to play] x will play y

But in (49), *him* is to the left of x.

The example (48) is an obstacle in the path of any attempt to interpret the Leftness Condition as a filter (or well-formedness condition) on representations at LF. Simply put, leftness is a phenomenon of surface structure order, and the operation QR (or, it seems, any other quantifier-adjunction rule) will have the effect of rearranging the order of constituents.[9]

[8] An anonymous reviewer has suggested that the reindexing operation given here is made necessary by the assumption of Chomsky (1980) that nonanaphoric NPs are at most contraindexed and never coindexed. This suggestion is mistaken. Suppose that the answer to the problem with which we began could be formulated as (H):

(H) Pronoun B can be bound to quantificational NP A in surface structure Σ iff:
(i) A, B are not contraindexed; and
(ii) There is a representation Σ^* of Σ at LF in which B is within the scope of A.

Then no reindexing would be necessary. We can even generalize (H) to cover cases such as (33) of the text, as follows. If S is a set of occurrences of NPs in Σ, we say that S is *maximal* iff S contains everything in Σ that is coindexed with anything in S. We say that S is *harmonious* if no two elements of S are contraindexed. Then we can propose (H′):

(H′) A set T of occurrences of pronouns can be bound to quantificational NP A in Σ iff there is a maximal, harmonious S such that:
(i) S contains A, and everything in T;
(ii) S–{A} is composed wholly of occurrences of pronouns and anaphors; and
(iii) There is an LF representation Σ^* of Σ such that every element of S–{A} is within the scope of A.

(H′) is inadequate because of "crossover", discussed below. Crossover aside, however, (H′) would be a solution to the general problem considered in this article, with no mention of reindexing.

[9] This is perhaps recognized in the more explicit formulation of the Leftness Condition given in Chomsky (1976, 202), as follows:

> Let us take [the Leftness Condition] to assert that a pronoun P within the scope of a quantifier may be rewritten as a variable bound by this quantifier unless P is to the left of an occurrence of a variable already bound by this quantifier.

That is, in our terminology, the reindexing rule is subject to a constraint on application, rather than an LF filter.

We turn now to a somewhat more subtle set of examples, of which the following are representative:

(50) a. Mary's seeing his father pleased every boy.
b. Seeing his father pleased every boy.
(51) a. Their getting letters from their sweethearts is important for many of the soldiers.
b. Getting letters from their sweethearts is important for many of the soldiers.
(52) a. For his wife to visit his old neighborhood would embarrass someone I know.
b. To visit his old neighborhood would embarrass someone I know.

The (b) examples above all freely allow binding of the pronoun in the subject sentence to the quantifier to its right. The (a) examples are much less acceptable in this respect.[10] The latter fact is a consequence of the Leftness Condition. But the Leftness Condition would likewise rule out binding in (50b), which clearly admits the interpretation (53):

(53) [every x: x is a boy] x's seeing x's father pleased x

The other (b) examples are similar. The difference between the (a) and (b) examples, I believe, is that in the (b) examples each subject sentence has a PRO subject, controlled by the quantifier, whereas in the (a) examples the subject position is lexically filled. PRO acts as a "gate" through which the genitive pronouns in the (b) examples can reindex; but the (a) examples have no gates. The phenomenon also occurs with WH:

(54) a. Who did her forgetting what he said to him annoy?
b. Who did forgetting what he said to him annoy?

In (54a), and again in accordance with the Leftness Condition, none of the pronouns can be bound to *who*. But in (54b), either pronoun can be bound to *who* (but not both, because the anaphoric index of *him* contains the referential index of *he*).

Suppose now that we assume that a pronoun reindexes to the index of a source trace which is to its left at the point of application of the Reindexing rule. The principle involved might be stated in various ways, depending on the notation adopted for this sort of rule. Informally, we may present it thus:

[10] If the context is properly rigged, then the (a)-type examples can become fully acceptable on the bound interpretation. For instance, Jacqueline Guéron gives (i):

(i) The teacher's writing to his father annoyed every child in the class.

Virtually this same example was suggested by Bonnie Gildin and others at Columbia. The view taken here is that (i) and the like are deviant structures on the bound interpretation, but that contextual factors including the meanings of the various quantifiers, etc., can combine to make some relatively accessible. But the (b) examples are readily interpretable as containing bound pronouns, independently of contextual factors, the meanings of the quantifiers, and other matters.

(55) *The Reindexing Rule*
In a configuration:
. . . e_i . . . pronoun$_j$ . . .
reindex j to i.

(55) thus permits us to coindex a pronoun with the index of an empty category to its left, regardless of whether this category is trace or PRO, and therefore regardless of whether PRO is formally assimilated to trace in the syntax or not.

We assume that (55) is optional, that it may reapply to the same pronoun, and that it is unordered with respect to the rule QR of quantifier construal.

Consider how the cases that we have discussed so far will fare under the proposal that (55) is the rule of Reindexing, subject to the convention (34). In typical crossover situations, binding will be impossible because the structure for the application of (55) will not exist. Thus, from (56) one derives (57) by QR:

(56) [his$_3$ father]$_2$ hates someone$_{4,\{2\}}$
(57) [someone]$_{4,\{2\}}$ [his$_3$ father]$_2$ hates e_4

No empty category with index 4 occurs to the left of *his* $_3$; so (55) cannot apply.

In cases such as (48), the bound interpretation is derived as follows. Given the indexed surface structure (58) (with irrelevant indices omitted), adjunction of the subject to S gives (59):

(58) [some musician]$_2$ will play [every piece you want him$_3$ to (play)]$_4$
(59) [$_S$[some musician]$_2$ [$_S$ e_2 will play [every piece you want him$_3$ to (play)]$_4$]]

The rule (55) may apply in (59), allowing 3 to become 2. QR then adjoins the object NP to the interior S, giving (60):

(60) [$_S$[some musician]$_2$ [$_S$[every piece you want him$_2$ to (play)]$_4$ [$_S$ e_2 will play e_4]]]

(60) represents the bound interpretation of (48).

After the first two steps of the above derivation, we could have adjoined the object NP to the exterior S. We would then derive (61):

(61) [$_S$[every piece you want him$_2$ to (play)]$_4$ [$_S$[some musician]$_2$ [$_S$ e_2 will play e_4]]]

In (61), *him* $_2$ will not be interpreted as a bound variable, because although coindexed with the quantifier *some musician* it is not within the scope of that phrase.

The rule (55) makes the correct predictions with respect to each of the examples in (50)–(52). In each of the (a) sentences, (55) is inapplicable; but in each of the (b) sentences, the controlled PRO may serve as a reindexing source. We turn now to the

question of whether the purported directional asymmetries in pronominal binding are to be taken as primitive.[11]

5. Leftness and *C*-Command

In all of the cases that we have considered so far, the empty category that served as a source for pronominal reindexing not only has been to the left of the pronoun to be reindexed, but also has *c*-commanded it. But analysis of two sorts of examples shows, I believe, that *c*-command of the pronoun by the empty category is not in general necessary for reindexing. The first kind of example involves "inversely linked" quantification in the sense of May (1977). Consider (62):

(62) Every daughter of every professor in some small college town wishes she could leave it.

The scopes of the quantified NPs in (62) are inverse to their surface order. Both *she* and *it* admit binding. Using QR and (55), we can derive from the surface structure of (62) the logical form (63):

(63) $[_S$[some small college town]$_2$ $[_S$[every professor in e_2]$_3$ $[_S$[every daughter of e_3]$_4$ $[_S$ e_4 wishes $[_{\bar{S}}$ she$_4$ could leave it$_2$]]]]]

Both at the point of application of Reindexing, and in the derived structure (63), e_2 fails to *c*-command *it*.

Say that the *depth* of an empty category $e_i = [_{NP}\, e]_i$ is the number of NPs dominating e_i. In all the "inversely linked" cases with PPs, such as (62), the depth of the empty category e_i will be at most 1 at the point where it serves as a source for the reindexing of a pronoun. Depth 1 can also be obtained in the rare cases of quantification into a relative clause, as in (64):

(64) Nobody who despises *anybody* lends *him* money.

[11] The central idea behind (55), that pronouns become bound variables through the mediation of empty categories appropriately related to them, may also account for the possibility of binding in examples like (i), first brought to my attention by Robert Fiengo:

(i) Devotion to *his* country is expected of *every soldier*.

Observe that purported coreference is not possible in (ii):

(ii) *Devotion to *Jack*'s country is expected of *him*.

The status of (ii) would follow at once from the Indexing Algorithm if we supposed that the subject NP had a PRO subject, coindexed with *him* (for analyses along these lines, see Lasnik (1976)). Then we have support for the idea that binding is possible in (i) because we may have the surface structure (iii):

(iii) [PRO$_i$ devotion to his$_j$ country] is expected of [every soldier]$_i$

The reindexing $j \rightarrow i$ is then possible through (55). We then predict that a bound interpretation should be less accessible in (iv) than in (i):

(iv) The Queen's devotion to *his* country inspires *every soldier*.

This prediction is borne out, I believe.

On the other hand, QR traces in Determiner position can have arbitrary depth. Assume that QR applies in sentences like (65) to produce logical forms like (66):

(65) Every boy's mother was amused.
(66) [every boy]$_2$ e$_2$'s mother was amused

Then e_2 has depth 1. In (67), the trace of *every boy* will have depth 2; and so on.

(67) [[[every boy]'s mother]'s best friend] likes tea

We can then consider the possibilities of binding in (68)–(72), for example:

(68) *Whose* mother loves *him*?
(69) *Every boy*'s father thinks *he*'s a genius.
(70) *Which man*'s dog do you think might bite *him*?
(71) *Some boy*'s father's best friend's daughter wants *him* to marry her.
(72) The teacher gave *every child*'s parents a report on *his* progress.

These seem acceptable to me; others may find them marginal (see, for instance, Lasnik (1976, 18)). In (72), the depth of the trace of *some boy* will be 3; deeper embeddings seem possible. The rules that we have stated so far will derive the bound interpretations of (68)–(72). We will assume in what follows that (55) is not subject to structural conditions in English.[12]

6. Lowering from COMP

Consider examples such as (73):

(73) **Who*se mother does *he* love?

In the theory of syntax assumed in this article, the indexed surface structure of (73) will be represented by (74):

(74) [who$_2$se mother]$_3$ does he$_4$ love e$_3$

Neither of *who, he* *c*-commands the other, so these items will not be contraindexed. Following the treatment of genitive quantifiers used in the last section, we would expect to obtain from (74) a logical form such as (75):

(75) [who]$_2$ [e$_2$'s mother]$_3$ does he$_4$ love e$_3$

In (75), the empty category e_2 is to the left of *he* $_4$; so, applying the Reindexing rule (55), we should be able to obtain the bound interpretation indicated in (73). But this interpretation is not possible.

[12] When the analysis presented in this article was first worked out, the research of Reinhart (1979) was unknown to me. I do not examine here the idea that pronominal binding is not in fact subject to conditions traceable to linear order, but only to structural conditions; but see Higginbotham (1980).

In Chomsky (1976), examples such as (73) were brought under the Leftness Condition through an operation which displaced from the COMP position everything except the *wh*-phrase itself. We call this operation *lowering*. Appeal to lowering resolves the problem of (73) within the assumptions of Chomsky (1976), because the position e_2—to be construed as a variable position—comes to be rightward of the pronoun. Lowering would also take care of (73) assuming the Reindexing rule (55), because its effect is to destroy the environment within which Reindexing is constrained to take place. Nevertheless, it seems to me that lowering is inadequate to account for all cases of the nature of (73).

There are two reasons for skepticism about the efficacy of lowering. One is in part semantic in nature, and I will sketch it below, without going at length into details. The other arises from matters which are endemic to the reindexing system in general, whether it is expressed as suggested in Chomsky (1976), or along the lines of this article. We consider the semantic objection first; the other is postponed until the next section.

Consider the following examples:

(76) Which driver of which millionaire's car was hired by his father?
(77) Which driver of which millionaire's car did his father hire?

It seems to me that (76), but not (77), can be interpreted as a general question; that is, *his* can be bound to *which millionaire* in (76) only. An answer to (76) as a general question might be (78):

(78) This driver of Ford's car and that driver of Rockefeller's car.

The impossibility of binding in (77) does not follow from constraints on purported coreference; (79) is acceptable:

(79) Which driver of *Rockefeller*'s car did *his* father hire?

(76) and (77) exhibit inversely linked quantification in COMP. Suppose that from (77) we were to obtain the logical form (80):

(80) [which millionaire]$_2$ [which driver of e_2's car]$_3$ did his$_4$ father hire e_3

Then (77) would pose the same problem for our analysis as (73) does. If the lowering operation were a general solution to the problems posed by (73) and the like, then it could be expected to apply at some point in the derivation of the logical form of (77). Could lowering produce (81)?

(81) [which millionaire]$_2$ did his$_4$ father hire [which driver of e_2's car]$_3$

From a purely formal point of view, the hypothesis that (77) has logical form (81) might indeed prevent pronominal binding in (77); but the suggestion is not yet even intelligible semantically. For what has been lowered in the case of (77) is not a referring expression, but rather an expression of generality, to which QR is supposed to apply. To make sense of (81), we would have to propose a semantics in which such expressions were

interpreted in place. Although there is no reason to suppose that such a semantics could not be produced, this price of the recourse to lowering in the case of (77) seems to me very high.

7. Constraints on Crossing

We now present a further problem for the analysis given to this point; suggest a mechanism for its solution; and show that this mechanism, if adequate, will obviate the need for a lowering rule for the examples discussed in the last section.

Consider (82) and (83):

(82) Everybody in some city hates its climate.
(83) Its climate is hated by everybody in some city.

Despite the obviously intended meaning, binding of *it* to *some city* is far less acceptable in (83) than in (82). But from the principles given so far, bound interpretations of either are obtained. In the case of (83), with relevant indices as in (84), we derive after two applications of QR the structure (85):

(84) it$_2$s climate is hated by [everybody in [some city]$_4$]$_3$
(85) [some city]$_4$ [everybody in e_4]$_3$ it$_2$s climate is hated by e_3

The rule (55) may now apply, reindexing *it* $_2$ as *it* $_4$. Since the pronoun is *c*-commanded by [*some city*]$_4$ at LF, it will be a bound variable.

In (83), we have repeated the problem posed by (73) and (77), this time using ordinary quantifiers. A bound interpretation of (83) could be derived because the variable which the quantifier *some city* binds can occur to the left of the pronoun at LF, even though the quantifier is to the right of the pronoun at surface structure. Suppose, however, that the Reindexing rule (55) were subject to the constraint that, at the point of its application, the configuration (C) could not be created:

(C) $\ldots [_{NP} \ldots e_i \ldots]_j \ldots$ pronoun$_i \ldots e_j \ldots$

I will call (C) the *Crossover Configuration*. It is exemplified by the result of reindexing the pronoun in (85), giving (86):

(86) [some city]$_4$ [everybody in e_4]$_3$ it$_4$s climate is hated by e_3

By the constraint just proposed, the bound interpretation of (83) is underivable (the bound interpretation of (82) is derived without hindrance from the proposed constraint). The restriction that (C) not be created by (55) will be referred to as the *C-Constraint*.

Assuming the C-Constraint, we can distinguish (76) from (77) above. In (76), binding is possible just as it is in (82); in (77), binding is blocked in the same way as for (83).

Given the C-Constraint, the lowering rule sketched in Chomsky (1976) and elaborated further in Guéron (1979) becomes superfluous, so far as the analysis of pronominal binding is concerned, for these cases (though that is not to say that lowering cannot be

independently motivated).[13] Suppose, for instance, that from (73) one derives (87):

(87) [who]$_2$ [e_2's mother]$_3$ does he love e_3

Then, by the C-Constraint, *he* cannot reindex to 2.

The C-Constraint states a condition on the application of the rule (55), and does not state a condition on structures derivable by (55) in conjunction with QR. For all the cases that we have considered up to now, however, the C-Constraint need not have been stated in this way; instead, we could just have prohibited the configuration (C) at LF. But an analysis of more complicated cases appears to show that (C) can appear in derived structures. Consider (88):

(88) Every friend of someone here knows someone who hates him.

(88) admits an interpretation in which *him* is bound to *someone here*. The derived structure is (89):

(89) [someone here]$_2$ [every friend of e_2]$_3$ [someone who hates him$_2$]$_4$ e_3 knows e_4

The Crossover Configuration is realized in (89). But there is a derivation of (89) (in fact, there are two) in which the C-Constraint is observed. Thus, the C-Constraint, like the condition on direction of reindexing, cannot (on the assumptions that we have made) be stated as an LF filter.

With the above cases, our preliminary analysis of pronouns as bound variables is completed. In brief review, the principles employed have been the following.

(90) The rule QR of quantifier construal, subject to constraints given in May (1977).

(91) The Reindexing rule (55) for pronouns; the rule is optional, and is unordered with respect to QR.

[13] It appears that some lowering operations might have to be performed before indexing, for instance to account for (i):

(i) *Which picture of *Fred* did *he* see?

There is at least one sort of case in which movement prior to indexing may affect possibilities for binding, but not for purported coreference, namely extraposition. The following example is noted in Partee (1975):

(ii) *It would be advisable for *everyone* for *him* to get a job.

Coreference in the italicized positions in (ii) is permitted:

(iii) It would be advisable for *him* for *John* to get a job.

The case (ii) would follow if we supposed that the structure to which indexing applies is that of the "intraposed" (iv):

(iv) *For *him* to get a job would be advisable for *everyone*.

However, if the pronoun to be bound in the extraposed clause is not a subject, then the sentences appear more acceptable than (ii):

(v) (?)It would be good for *everyone* for Harry to meet *him*.

Contrast (vi):

(vi) *For Harry to meet *him* would be good for *everyone*.

So matters are not so clear.

(92) The convention (34) on the Reindexing rule; this ensures, via May's (1979) device of "contradictory indices", that binding is constrained by coreference.

(93) The C-Constraint.

The principles given above do not reduce the directional asymmetries associated with pronominal binding to any more fundamental facts. What these principles do provide, to the degree that they are materially adequate, is an expression of what the asymmetry consists in, within the framework of Chomsky (1980). The convention (34) writes into binding conditions the conditions on purported coreference; and the C-Constraint serves to "encode" the fact that an empty category e_i, otherwise available via (55) as a source for reindexing, cannot serve as such a source in cases where the phrase that binds it "originated" in an embedded position to the right of the pronoun. *Origin* is not immediately determined by surface structure position, as the examples with *wh* illustrate. The ad hoc appearance of the C-Constraint in particular might be remedied somewhat if it could be seen as a special case of some other conditions. In concluding the main exposition of this article, I will report briefly on some research of mine into Chinese, which perhaps gives some hope that the C-Constraint has just such status.

8. The Case of Chinese

In Mandarin Chinese, it is not difficult to verify the existence of conditions on purported coreference, directly comparable to English conditions in simple cases. Binding is constrained by coreference in Chinese, as in English. Despite the absence of morphological Tense, the assumption that Tense is in fact present, and that verbs are marked for whether or not they can take tensed complements, leads to systematic and correct predictions, for instance, in the case of verbs of propositional attitude. The question-words corresponding to *who, what,* etc., do not move in Chinese. When one turns to pronominal binding, the Leftness Condition holds:

(94) Shéi kanjyàn tā mǔchin?
who see he mother

(95) Tā mǔchin kanjyàn shéi?
'Who did his mother see?'

(94), but not (95), can be interpreted as a general question. (In the above and in subsequent examples, I employ the Yale system of transliteration—the characters are not included, since these are easily recoverable from the English translations.) As in English, there are "gates" which allow pronouns to be bound to quantifiers occurring on their right at surface structure:

(96) Kanjyàn tāde mǔchin ràng shéi dōū hěn gāūsying.
see his mother make everyone very happy
'Seeing his mother made everyone very happy.'

In (96), *tā* can be bound, presumably through the PRO subject of *kanjyàn* (one informant said that on the bound interpretation of (96) her image was of prisoners in a jail, whose mothers were being allowed to visit them).

When one turns to *shéi* embedded in NPs, however, a distinction between English and Chinese emerges:

(97) Shéi de mǔchin kanjyàn tā?
who mother see him
'Whose mother saw him?'

(97) is unambiguous: the pronoun can only be deictic. (98) is a similar case:

(98) Shéi de mǔchin dōū kanjyàn tā.
'Everyone's mother saw him.'

(Wyn Chao informs me that the analogues of (97) and (98) are likewise unambiguous in her dialect, Cantonese.) On the assumption that (97) has surface structure (99) and that QR applies to yield (100),

(99) $[_S[_{NP}[_{NP}$ shéi] de $[_{\bar{N}}$ mǔchin]] $[_{VP}$ kanjyàn tā]]
(100) $[_{NP}$ shéi$]_2$ $[_S[_{NP}$ e$_2$ de mǔchin] kanjyàn tā]

the hypothesis suggests itself that the depth of the trace e_2 may be responsible; for (94) is ambiguous. The most powerful generalization would be that the Reindexing rule in Chinese is subject to the constraint that the source trace must *c*-command the pronoun to be reindexed; this constraint might be expressed by the principle that the Reindexing rule cannot apply so as to create the configuration (CC):

(CC) $\ldots [_{NP} \ldots e_i \ldots]_j \ldots$ pronoun$_i \ldots$

The configuration (C) is then a special case of (CC), and the binding possibilities in Chinese, therefore, a proper subset of the binding possibilities for English. Roughly speaking, English permits violations of (CC) in the "uncrossed" cases, but not the "crossed" cases. We may be able to motivate (C), therefore, by showing that it is the constraint which results when (CC) is weakened.[14]

[14] See Higginbotham (1980) for a conjecture. The configuration (CC) is realizable for my informants in the case of the quantifier *yǒu*, whose force is existential:

(i) *Yǒude nyǔhaidz*de péngyou dōū kanjyàn *tā*.
a girl's friend all see her
'Every friend of *a girl* saw *her*.'

The force of this example is small, however, because *yǒu* occurs other than as a determiner. When one turns to quantifiers that only appear in determiner position, then binding appears to obey the constraint (CC). Thus, we find (ii):

(ii) **Měi yige nyǔhaidz*de péngyou dōū kanjyàn *tā*.
every girl friend all see her

It has proved very difficult to obtain relevant data on the "inversely linked" cases, because the constructions themselves are felt as marginal unless topicalized.

I would like to thank Chung-Keng Ch'ou, Jim Huang, Irene Lyou, and others for their assistance.

9. Special Constructions

Supposing some degree of adequacy for the analysis presented above, it may be possible to use this analysis as a tool for understanding more complex constructions than those considered up to now. In concluding this article, I will consider some cases that seem relatively clear. These are: (i) partitives and *only*; (ii) the dative passive, and some questions on argument positions; (iii) relative clauses and clefts.

Before we proceed, it will be well to recall a respect in which the Indexing Algorithm is incomplete; namely, that algorithm fails to allow overlapping reference between a genitive pronoun and an NP which *c*-commands it, except when the Opacity Condition applies. Defining *genitive* as *domain of* $\bar{N}$, the problem is to explain why construal, bound-anaphora, and overlapping reference are all possible in this domain. We will not undertake an examination of this problem here; but it will be assumed in what follows that referential indices of *c*-commanding NPs delete from the anaphoric indices of genitive, nonanaphoric pronouns. Then binding is possible in sentences such as (101):

(101) *Every boy* loves *his* mother.

Because the exposition of the matters following will be less involved and the examples in general much clearer with the assumption, we will use it freely.[15]

9.1. *Partitives and* Only

Consider (102)–(104):

(102) Only John expects to win.
(103) Only John expects him to win.
(104) Only John expects that he will win.

(Cases of this sort are discussed in Partee (1975).)

(102) is unambiguous: what is asserted is that John and John alone has expectations of winning. (103) admits two interpretations, neither of which is equivalent to (102). On the first, John and John alone expects that he, John, will win; the others expect someone other than John to win, if they have any expectations at all as to the winner. On the second, *him* refers to some individual *a* given outside the sentential context, and what is asserted is that John alone expects *a* to win. (104) admits an interpretation in which *he* refers to *a* similarly; on this interpretation, it is equivalent to the second interpretation of (103). Besides this interpretation, (104) is ambiguous between an interpretation equivalent to (102), and an interpretation equivalent to the first interpretation of (103). Now, all these facts follow from the Indexing Algorithm, and the analysis of pronominal binding given here, on the assumption that QR applies to phrases such as *only John*.[16]

[15] See Fiengo and Higginbotham (1979) for an analysis of the genitive in the context of the theory of Chomsky (1980).

[16] Here I am indebted to Robert May.

(102) is a case of control. From the indexed surface structure (105),

(105) [only John$_3$]$_2$ expects [$_{\bar{S}}$ for e$_2$ self to win]

in which the anaphor has been coindexed, not with *John* $_3$, but with the *c*-commanding [only John$_3$]$_2$, in accordance with the general requirement on anaphors ((10) in section 1 above), we obtain (106) by QR:

(106) [only John$_3$]$_2$ e$_2$ expects [$_{\bar{S}}$ for e$_2$ self to win]

The interpretation of (106) might be represented more transparently by (107):

(107) [only x_2: x_2 = John$_3$] x_2 expects x_2 to win

(See above, footnote 7.) (106) is the only well-formed logical form that can be derived from (102) (up to alphabetic variance on indices), and it has uniquely the single interpretation of that sentence.

Turning to (103), it follows from the Indexing Algorithm that *him,* being the subject of an infinitive, will be contraindexed with the subject NP *only John.* Therefore, it cannot be bound to this expression, and a logical form with the interpretation of (106) cannot be derived. On the other hand, since *John* does *not* *c*-command *him* in (103), these expressions can be purported to be coreferential. If they are taken to be so purported, then one obtains the first interpretation given above of (103), and if they are not one obtains the second.

In (104), finally, the embedded pronoun is the subject of a tensed clause; hence, the NIC applies, and binding of the pronoun to *only John* is possible, giving an interpretation corresponding to that of (102). Since *he* may be purported to be coreferential with *John,* (104) has in addition both the interpretations of (103).

The above analysis of *only*-phrases accounts for the distinction between (108) and (109), discussed at length by Fodor (1975, 133–145):

(108) Only Churchill remembers giving the speech.
(109) Only Churchill remembers his giving the speech.

(108), like (102), is a case of control; but (109) is three ways ambiguous, just as (104) is.

We turn now to quantificational partitive NPs. These pattern with respect to pronominal binding in the same way as *only*-phrases. Consider (110)–(112):

(110) Several of the men expect to work past midnight.
(111) Several of the men expect them to work past midnight.
(112) Several of the men expect that they will work past midnight.

(110) asserts unambiguously that there are several x, x among the men, such that x expects x to work past midnight. (111) does not have this interpretation, but does admit an interpretation with *them* = *the men*; in this case, the meaning is that for several x, x among the men, x expects the men to work past midnight. Last, (112) is ambiguous between the above.

At first sight, the following use of partitives may seem to be a counterexample to the above analysis of pronominal binding:

(113) Their fathers hate all the men.

Assuming the antecedent of *their* to be given within the sentence, (113) is still ambiguous between the following two interpretations, where S is the plurality denoted by *the men*: (i) every father of a member of S hates each member of S; (ii) every member x of S is hated by x's father. The logically stronger interpretation (i) of (113) is available within the analysis given here. Because *their* does not *c*-command *the men,* the pluralities denoted by these expressions can be identical; if they are, then (i) results. The interpretation (ii) is logically equivalent to the indicated reading of (114):

(114) *All the men* are hated by *their* fathers.

In (114), the interpretation (ii) is available through the reindexing of *their* to the index of *all the men,* whose trace will be to the left of the pronoun. But no source for reindexing is made available in (113).

But consider (115):

(115) Their fathers hate the men.

It seems that (115) by itself admits the interpretation (ii) of (113), although in this case no quantifier is present. If so, then the availability of (ii) for (113) might be ascribed to the presence of the plural definite *the men,* rather than to "backwards binding". The article must be present, as (116) shows:

(116) Their fathers hate all men.

In (116), binding is impossible; the sentence can mean only that the fathers of a certain collection of men are misanthropes. The ambiguity of (113) is not, then, a counterexample to the analysis given here; but its description and explanation fall outside the domain of pronominal binding by quantificational NPs, so it would seem.[17]

9.2. *Argument Positions*

The Reindexing rule (55) is blind to the status at LF of the empty category e_i to whose referential index pronoun$_j$ reindexes. In particular, then, j may reindex to i, NP$_i$ not quantificational, when e_i is the trace of NP Movement, or a controlled PRO. In both (117) and (118), the reindexing 3 → 2 is permitted.

(117) John$_2$ was seen e$_2$ with his$_3$ mother.

[17] Similar remarks hold for generics; see Higginbotham (in preparation).

(118) PRO_2 watching his_3 father fall upset $John_2$.

Our analysis implies that some, but not all, possibilities of coreference will be directly representable at LF.[18]

Consider dative passives with inversely linked *wh*-phrases, as in (119)–(121):

(119) Which book about *which naturalist* was given to *his* father?
(120) Which book about *which naturalist* was given *his* father?
(121) *Which book about *which naturalist* was *his* father given?

Assuming the judgments above, (119) and (121) are as predicted; it is the acceptability of (120) that raises questions. On an analysis in which the indexed surface structure of (120) is, for example, (122),

(122) [which book about [which naturalist]$_3$]$_2$ [$_S$ e_2 was given [his_4 father] e_2]

in which the indirect object is to the left of the trace of the direct object, the reindexing $4 \rightarrow 3$ cannot apply, because of the C-Constraint. One might remark that, of the two occurrences of *e* in the matrix S of (122), the second does not represent an argument position, and so exempt the reindexing from the C-Constraint, in this case. However, this complication is unnecessary if, after Fiengo (1980), one assumes that direct and indirect objects can occur in either order following V. For then, besides (122), the surface structure (123) also underlies (120):

(123) [which book about [which naturalist]$_3$]$_2$ [$_S$ e_2 was given e_2 [his_4 father]]

In this case, $4 \rightarrow 3$ will not violate the C-Constraint.

There are further data involving binding that support Fiengo's "free ordering" hypothesis:

(124) Into *which child*'s hands shall I put *his* candy?
(125) **Which child*'s hands shall I put *his* candy into?

In (125), the stranded preposition forces violation of the C-Constraint, assuming no lowering (see above, section 6). Furthermore, any lowering in (125) must be to the vacated object-position of *into,* and so will yield no source for reindexing. But in (124), using Fiengo's hypothesis that the source of *into which child's hands* can be immediately after the V *put,* the pronoun can reindex freely. The examples below are similar.

(126) *Which person* did you talk about with *his* wife?
(127) **Which person* did you talk with *his* wife about?
(128) To *whom* did you send *his* books?
(129) **Who* did you send *his* books to?

It seems, then, that accounting for the data presented in this section need not force any complications in the statement of the Reindexing rule. We turn now to the cases of relative clauses and clefts.

9.3. *Relatives*

We consider first the contrast between pairs such as (130) and (131):

(130) The singer of his song–knows Fred.
(131) The person who sang his song–knows Fred.

In (131), binding is permitted: the subject NP can be interpreted as referring to the *x*, *x* a person, such that *x* sang *x*'s song. For (130), this interpretation of the subject NP is impossible.

Of course, where the reference of *his* = *a,* it might turn out that *the singer of a's song* = *a*. Moreover, such coreference might even be purported; viz. (132):

(132) John is the best singer of his song.

In general, a description may overlap in reference with an NP properly contained within it.

The distinction between the descriptions in (130) and (131) is therefore not a matter of conditions on purported coreference, but rather a matter of binding. Semantically—and speaking loosely—the descriptions differ in that only the description *the person who sang his song* can be used to establish the identity of an object without fixing the reference of the pronoun *his* from outside. This difference is what is represented by the possibility of binding in (131), but not in (130).[19]

The source of binding in (131) is of course the trace of *Wh* Movement in the relative clause. Pronominal binding in this situation continues to be subject to directional asymmetries:

(133) I know every boy *who* loves *his* mother.
(134) *I know every boy *whom his* mother loves.

[18] We might speculate further that the Reindexing rule is insensitive to whether the source empty category plays any semantic role at all. Many people, myself included, find binding in (i) more acceptable than in (ii):

(i) Who do you think his father hates?
(ii) Who does his father hate?

Suppose that, as in Chomsky (1977b), we assume the successive cyclicity of *Wh* Movement. Then the indexed surface structure of (i) will be as shown in (iii):

(iii) who_2 do you think [$_S$ e_2 [$_S$ his_3 father hates e_2]]

Then the Reindexing rule, applying blindly, could recognize the semantically inert empty category in COMP as a source. This would yield a bound interpretation of (i).

That some possibilities for coreference are now given by rules of grammar, as in (117) and (118), does not contradict the general point of view of Chomsky (1980) or Lasnik (1976), that optional coindexing is superfluous for referential expressions. Rather, these possibilities obtain on the present analysis, just because there is no reason to complicate the Reindexing rule so as to prevent them.

[19] Turning to idioms, the contrast between pairs of NPs of the sorts displayed in the examples above is still more striking. Thus, we can have (i) but not (ii):

(i) the person who blew his cool
(ii) *the blower of his cool

For further remarks, see Higginbotham and May (1979).

It is straightforward to verify that the other conditions that we have discussed also hold in the domain of a relative $\bar{S}$.

There is an intuitive semantic distinction between the restrictive and the nonrestrictive relatives. Roughly speaking, the head NP of a restrictive relative $[_{NP}$ NP $\bar{S}]$ is *incomplete*; it has no reference at all in such occurrences. But the head of a nonrestrictive relative has a determinate reference. Compare (135) and (136):

(135) The man, who I know his wife loves, admires Mozart.
(136) The man who I know his wife loves admires Mozart.

In (136), the pronoun cannot be interpreted as a bound variable. As in other examples, coreference between the pronoun and the containing NP is possible:

(137) The man who I know his wife loves is Fred.

(137) can be true with *his = Fred = the man who I know his wife loves*. But coreference between *his* and *the man* is out of the question in (136) or (137); the expression *the man,* as it there occurs, is not to be taken as referring to anything at all, so I would maintain. But in (135), a nonrestrictive relative, the head NP *the man* is semantically complete, and has a reference. Notice that coreference between *his* and *the man* is entirely possible, although binding is impossible.

But coreference between the head of a nonrestrictive relative and a pronoun contained in the relative clause is nevertheless subject to restrictions; viz. (138):

(138) **John,* who *he* hates, knows Fred.

To analyze this phenomenon within the framework assumed here, we first advert to a discussion of the role of anaphoric indices for other cases than the contraindexing of referential NPs.

Recall that if NP_i contains j as an element of its anaphoric index, then this is to have the following interpretation: the reference of NP_i does not purportedly overlap with the reference of any NP with referential index j. This statement, however, is significant only if NP_i, NP_j are both referential. If either is interpreted as a variable, or is quantificational, then the question of reference does not arise. On the other hand, we can associate with a quantificational NP a *universe of discourse,* and correspondingly with each occurrence of a variable a set of *admissible values* of that variable. In many cases, restrictions on values of variables appear to be influenced by the same factors that determine failure of purported coreference. Thus, compare (139) and (140):

(139) John hates him.
(140) Someone hates him.

(139) cannot be interpreted as an assertion that John hates himself. Similarly, it seems to be a necessary condition for the truth of (140) in ordinary discourse that b hate a be true for some $b \neq a$. In the dual situation of (141),

(141) Everyone hates him.

if *him* refers to a, it is not necessary for the truth of (141) that a hate a. Finally, in cases of multiple quantification such as (142),

(142) Everyone wants someone to be rich.

the favored interpretation is that each person is an x such that for some $y \neq x$, x wants y to be rich.

Suppose that NP_i, NP_j are quantificational NPs, contraindexed in a surface structure Σ. Then they are also contraindexed at LF, and one must be within the scope of the other (otherwise they would not have been contraindexed at SS). If NP_j is within the scope of NP_i, then the favored interpretation results by including the clause "$x_i \neq x_j$" within the restriction on NP_j. Thus, (142) will be interpreted as shown in (143):

(143) [every x: x is a person] x wants [[some y: y is a person & $y \neq x$] y to be rich]

Such is the interpretation of "disjoint reference" applied to quantificational NPs.[20]

For the simpler case, suppose that NP_i is quantificational, NP_j is referential, and they are contraindexed. Then the favored interpretation includes the clause "$x_i \neq NP_j$" or "$x_i \notin NP_j$", depending on whether NP_j is singular or plural.

Consider again (138), repeated here:

(138) **John,* who *he* hates, knows Fred.

The referential index of *who* in (138) will be an element of the anaphoric index of *he*; in short, these items will be contraindexed. Then it follows from the interpretation of contraindexing just suggested that in the structure (144)

(144) $[_{\bar{S}}[\text{who}]_3\ \text{he}_{4,\{3\}}\ \text{hates}\ e_3]$

the reference of the pronoun is excluded as a possible value of the variable bound by *who*. But since the nonrestrictive relative as a whole refers to John, it is proper to assume that John is among the admissible values of this variable. Then the reference of the pronoun cannot be to John.

The analysis just given extends to pronouns occupying other positions in nonrestrictive relatives:

(145) **John,* who hates *him,* . . .
(146) *John,* who hates *his* father, . . .
(147) *John,* who *his* father hates, . . .
(148) *John,* whose father hates *him,* . . .
(149)(?)*John,* whose father *he* hates, . . .

[20] Thanks to the reviewer who forced me to make this interpretation explicit.

The slight oddity of (149) calls for explanation, particularly since there are nonrestrictives on this pattern that are clearly unacceptable:

(150) **The shah,* through whose father's usurpation *he* became king, . . .
(151) ??*John,* whose face *he* shaves regularly, . . .

What the explanation may be is not clear.[21]

With the exception just noted, the appropriate generalizations, which follow from the analysis given here, are (152) and (153):

(152) In a nonrestrictive relative, a pronoun not contraindexed with the relative *wh* can be coreferential with the head.
(153) In a restrictive relative, pronominal binding follows the pattern of direct and indirect questions.

In (1979), Chomsky suggests that the data discussed above, on "disjoint reference" and quantification, arise not from the rules of grammar, but from independent consid-

[21] Milner (1979) observes that the analogue of (148) is quite unacceptable in French:

(i) **Jean,* dont le père *le* haït, . . .

Milner also mounts an argument for the successive cyclicity of *Qu* Movement in French, based on facts involving disjoint reference. The relevant data hold also in English. We cannot have (ii):

(ii) **John,* who you know *he* said would attend, . . .

The explanation assuming successive cyclicity would be that the trace of *Wh* Movement in the COMP of [$_S$ COMP [$_S$ *he said would attend*]] implies that the anaphoric index of *he* contains the referential index of the moved element.

The discussion in the text assumes that the *wh* of every relative is quantificational; that is, that it binds variables. Milner (1979) shows in detail that conditions on disjoint reference are reflected in relatives, concluding therefrom that relative pronouns are "referential". But it appears that Milner's data (from French) are accounted for on the analysis suggested here, which assumes that relative pronouns are quantificational but constrained in admissible values of variables by the conditions on disjoint reference.

In the text, I have refrained from assuming with Chomsky (1976) that variables have the status of names at LF. Suppose that this assumption were added to the rules and principles employed above, in the form (A):

(A) Variables are assigned anaphoric indices.

Then (A) predicts the status of (iii),

(iii) **John,* who *he* hates, . . .

on the assumption that *John* and *who* are coindexed at LF. We will have (iv),

(iv) John_2, who_2 $\text{he}_{3,\{2\}}$ hates $\text{e}_{2,\{3\}}$

so that construal of he_3 as $John_2$ will assign the index 2,{2} to the trace e_2, an LF variable. But application of (A) is inessential for (iii), because under the construal $3 \rightarrow 2$ *he* will also bear this index. So (A) is redundant in this and other cases discussed in the text, as the reader may verify.

Notice now that (A) predicts the status of (ii) and the like independently of the question of successive cyclicity of *Wh* Movement, because *he* will *c*-command the trace of *who*. A powerful case for (A) appears to follow from examples such as (v), first brought to my attention by Robert Fiengo:

(v) **John,* who I saw *his* picture of, . . .

In (v), the referential index of *who* will delete from the anaphoric index of *his,* by whatever principle allows coreference between genitive NPs and NPs that *c*-command them. Yet, *his* and *John* cannot be coreferential. If (A) were assumed, however, then the trace of *who* would have the referential index of *his* as part of its anaphoric index. The status of (v) then follows at once.

Acceptance of (A) in the light of (ii), (v), and similar examples will not alter the analysis in the text at all, it appears.

erations on common-sense belief and principles of language use. Certainly, there is nothing absurd in, say, the inference (154), despite the favored interpretation of the conclusion.

(154) Everyone wants himself to be rich; therefore, everyone wants someone to be rich.

Likewise, if (155) is true,

(155) Carter voted for everyone on the Democratic ticket.

then we naturally assume that it is asserted in particular that Carter voted for himself. In the text, I have suggested that it is (154), (155), and the like that call for special explanation in terms of common-sense belief and conditions on language use, rather than the presumptions of disjointness in the quantificational cases. The issue is not over the data, but over their explanation.

However, a weakness for the analysis given here appears to emerge no matter how the data are explained. For suppose that we wish to extend the analysis to account for (154), (155), and the like, while retaining the proposition that a pronoun cannot be bound to a quantificational NP with which it is contraindexed. How would this be done? A natural suggestion is that there are principles of some sort, perhaps "pragmatic" in nature, that remove restrictions that the grammar would otherwise impose. These principles could be expressed by the optional deletion of elements of anaphoric indices, under certain circumstances. So in, say, (156),

(156) $[\text{someone}]_i$ e_i hates $\text{him}_{j,\{i\}}$

we might permit *i* to delete from the anaphoric index of him_j, thereby allowing inclusion of its reference in the domain over which the quantifier ranges. Call these principles *relaxation rules*. Still, however relaxation rules are formulated, we must *not* be able to delete *i* from the anaphoric index of an element with referential index *i*. To do so would be to permit the impossible cases of binding. Hence, so far as can be seen, one would have to incorporate a special principle barring as inputs to the relaxation rules structures that contained indices of the form (157):

(157) $i, \{. . . i . . .\}$

In short, the impossibility of binding in cases like (156) would no longer follow automatically from the interpretation of contraindexing. With this change, the analysis given here would lose a good deal of its explanatory force, although its material adequacy would be unaffected. I hope to take up these issues elsewhere.

In concluding this article, we turn to cleft sentences. It turns out that they exhibit the pattern of restrictives rather than nonrestrictives. The critical examples are (158) and (159):

(158) *It was *John* whose friend *he* betrayed.
(159) *It was *John* who *his* friend betrayed.

The contrast between (159) and (160) is especially striking:

(160) *John,* who *his* friend betrayed, is a nice fellow.

Assuming the analysis of clefts given in Chomsky (1977b, 94–95), (159) will have the surface structure (161), in which *John* is Topic of $\bar{S}$.

(161) it was [$_{\bar{S}}$[$_{TOP}$ John] [$_{\bar{S}}$[who]$_i$ [$_S$ his friend betrayed e_i]]]

From our earlier analysis, it follows that *his* cannot be a bound variable in (161), but one must explain further why it cannot be coreferential with the semantically complete Topic. At the moment, I see no solution to this problem that goes much beyond stipulation. There are some suggestive data, however, which may indicate that the solution resides in a more accurate analysis of conditions on purported coreference in equative constructions, of which clefts are an instance. Thus, consider (162)–(165):

(162) **Mary* is *her* cook.
(163) **We* are *our* friends.
(164) **His* friend denied being *Bill.*
(165) **Fred* wanted to become *his* housekeeper.

These are in contrast to (166)–(169):

(166) *Mary* likes *her* cook.
(167) *We* look after *our* friends.
(168) *His* friends denied knowing *Bill.*
(169) *Fred* wanted to see *his* housekeeper.

In equative constructions, then, one cannot have coreference between the genitive NP which is determiner of NP to one side of the copula and NP on the other side. This property of equatives is preserved in negation:

(170) **Mary* isn't *her* cook.
(171) **We* aren't *our* friends.
(172) **His* friend didn't deny being *Bill.*
(173) **Fred* didn't want to become *his* housekeeper.

Furthermore, it is not semantic; compare (174) to (175):

(174) **That number* is *its* square.
(175) *That number* is identical to *its* square.

Notice that when the genitive is embedded further down, then coreference becomes possible:

(176) *Mary* is *her* cook's best friend.

We might conjecture, then, that equative constructions are marked exceptions to the principles which allow purported coreference in (for example) (166)–(169). If so, it might follow that *who* in (159) cannot include the reference of *his* among the values of its variables; in this way, the data concerning clefts would be accounted for. Then coreference should be possible in (177):

(177) It was *John* who *his* friend's mother betrayed.

This conclusion seems to me correct, but it remains to spell out the principles governing (162)–(165) and (170)–(174).[22]

References

Chomsky, N. (1976) "Conditions on Rules of Grammar," *Linguistic Analysis* 2; reprinted in N. Chomsky (1977a), 163–210.

Chomsky, N. (1977a) *Essays on Form and Interpretation,* North-Holland, New York.

Chomsky, N. (1977b) "On *Wh*-Movement," in P. W. Culicover, T. Wasow, and A. Akmajian, eds., *Formal Syntax,* Academic Press, New York, 71–132.

Chomsky, N. (1979) "Pisa Workshop Lectures," transcribed by Jean-Yves Pollock and Hans Obenauer.

Chomsky, N. (1980) "On Binding," *Linguistic Inquiry* 11, 1–46.

Edwards, J., R. Fiengo, and J. Higginbotham (in preparation) "Equatives."

Fiengo, R. (1980) *Surface Structure,* Harvard University Press, Cambridge, Massachusetts.

Fiengo, R. and J. Higginbotham (1979) "Opacity in NP," forthcoming in *Linguistic Analysis.*

Fodor, J. A. (1975) *The Language of Thought,* Thomas Y. Crowell, New York.

Guéron, J. (1978) "On the C-Command Criterion for Coreference," ms.

Higginbotham, J. (1979) "Pronouns and Bound Variables," in E. Battistella, ed., *Proceedings of the Ninth Annual Meeting of the North Eastern Linguistic Society,* CUNY Forum, New York, New York.

Higginbotham, J. (1980) "Anaphora and GB: Some Preliminary Remarks," forthcoming in John T. Jensen, ed., *Proceedings NELS X̄, Cahiers Linguistiques d'Ottawa,* Ottawa, Ontario, Canada.

Higginbotham, J. (in preparation) "Indices and Interpretations."

Higginbotham, J. and R. May (1979) "Crossing, Markedness, Pragmatics," forthcoming in *Proceedings, G.L.O.W. IV,* Pisa, Italy.

Kaplan, D. (1969) "Quantifying In," in D. Davidson and J. Hintikka, eds., *Words and Objections: Essays on the Work of W. V. Quine,* D. Reidel, Dordrecht, Holland, 206–242.

Lakoff, G. (1968) "Pronouns and Reference," distributed by the Indiana University Linguistics Club, Bloomington, Indiana.

Lasnik, H. (1976) "Remarks on Coreference," *Linguistic Analysis* 2, 1–32.

May, R. (1977) *The Grammar of Quantification,* Doctoral dissertation, MIT, Cambridge, Massachusetts.

May, R. (1979) "Must COMP-to-COMP Movement be Stipulated?" *Linguistic Inquiry* 10, 719–725.

May, R. (forthcoming) "Movement and Binding," *Linguistic Inquiry.*

Milner, J.-C. (1979) "Cyclicité successive du Mouvement de *qu,*" ms.

[22] Jan Edwards, employing in part suggestions of Robert Fiengo and the author, has examined this topic in unpublished work; she suggests that principles of case assignment are intimately involved. See Edwards, Fiengo, and Higginbotham (in preparation).

Partee, B. H. (1975) "Deletion and Variable Binding," in E. L. Keenan, ed., *Formal Semantics of Natural Language,* Cambridge University Press, London, 16–34.
Quine, W. V. (1956) "Quantifiers and Propositional Attitudes," reprinted in *The Ways of Paradox,* Random House, New York, 183–194.
Reinhart, T. (1979) "Syntactic Domains for Semantic Rules," in F. Guenther and S. J. Schmidt, eds., *Formal Semantics and Pragmatics for Natural Languages,* D. Reidel, Dordrecht, Holland, 107–130.
Russell, B. (1905) "On Denoting," reprinted in R. C. Marsh, ed., *Logic and Knowledge,* George Allen and Unwin, 41–56.

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Adjacency and Variables in Syntactic Transformations*

0. Introduction

In this article I will be proposing a general convention on the functioning of syntactic transformations in which all rules can be said to affect only adjacent terms—as long as the theory contains the proper notion of adjacency. The definition of *adjacent terms* which will arise here is one which was developed in detail in Wilkins (1977) within a model of constraints using the Variable Interpretation Convention (VIC) for which "grossest constituent analysis" (GCA), a condition on how phrase markers are analyzed, was defined. By use of the VIC, a theoretical model is constructed in which constraints on the applicability of transformations are determined by the *interaction* of the *form of rules* and the Convention. The VIC model is an alternative to constraining transformations either by output conditions (cf. Chomsky and Lasnik (1977)) or by conditions on rule functioning alone (cf. Ross (1967)). The VIC, along with a revised version of the Left Branch Condition (Ross (1967)), incorporated into linguistic theory as a condition on grammars, can be shown to be an alternative to several separate, already proposed conditions. As such, the VIC allows for a simpler statement of rule conditioning and, hence, a preferred theory of grammar. At least with respect to movement rules, the VIC (with the Left Branch Condition) replaces the Specified Subject, Superiority, Tensed-S, and Subjacency Conditions (Chomsky (1973)) and from it follow both the A-over-A Condition (Chomsky (1962) and elsewhere) and the principle of the transformational cycle. Additionally, with the VIC, it can be shown that WH Fronting is, in principle, a rule which functions over an unbounded domain but one which, because of phrase structure configurations and subcategorizations (at least for English), seems to affect only subjacent domains.

There are two basic components to the VIC approach. One is that the terms which may be mentioned in a structural description (SD) of a reordering transformation are subject to a very strong restriction, namely, that only terms which are crucially affected may be included in an SD. The second component of the approach is a condition on

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