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Item Type	article;article
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Download date	2025-04-24 17:33:12
Link to Item	https://hdl.handle.net/20.500.14394/36413

ANAPHORIC BINDING AND THE DEFINITION OF PRO

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1. Much recent work in generative grammar has centered on determining the exact status of dependent elements in the grammar: either overt referentially dependent elements (lexical anaphors, pronouns), or null elements of various types. A central empirical claim, with respect to empty categories, is that each sort of empty category should not be conceived of simply in isolation as corresponding to a particular bundle of properties, but that the set of empty categories themselves form a system, defined in terms of the more primitive feature set +/- anaphor and +/- pronominal (Chomsky, 1981). The properties of a given element would then (ideally) follow from the specification of its individual features; a central question, in such a system, is exactly what the assignment of a particular feature, e.g. +anaphor, entails.

The element PRO in the system above has had a rather unique status as a pronominal anaphor. In Chomsky (1981), these features are viewed as simultaneously holding of all occurrences of the element. Bouchard (1982) presents an interesting alternative, in which PRO is viewed as anaphoric when bound locally, and pronominal when bound long distance. These correspond to two alternate views of the interpretation of the feature set, applying either conjunctively or disjunctively to occurrences of the element. In this paper, I will explore the consequences of adopting a rather different position, namely:

- 1 a) PRO is a necessarily dependent element, and must be bound in a local domain D (to be specified).
- b) PRO may be either A- or A'- bound; it is unspecified for the position of its binder.

The conclusion that PRO is a necessarily dependent element would make it technically an anaphor, assuming that the term may encompass A' relations of this sort (cf. Aoun, 1981). The "pure anaphoric" status of PRO has been suggested by Manzini (1983) and Sportiche (1983), as well as in earlier work by myself (Lebeaux, 1983). I will be concerned here principally with the broader implications that such a position has for the definition of anaphor: that it is necessarily dependent, for example, but not restricted in other ways (e.g., not specified as not allowing split antecedents).

2. Certain pre-theoretical observations would seem to support the general notion that PRO is a +pronominal, +anaphor, especially in the "disjunctive interpretation" given above. For example, there is the existence of arbitrary PRO, an apparently free element. And there are cases of the long distance binding of PRO, given in 2 a) below. The long-distance binding of PRO here contrasts with the binding of the overt anaphor in 2 b).

- 2 a) John thought that Mary had said that PRO shaving himself would not be difficult.
- b) *John and Bill thought that Mary had said that pictures of each other were on sale.

Nonetheless, even in these constructions, an analysis in which PRO is acting as a simple pronoun is problematic. One difference has to do with the domain in which the antecedent may be found. While PRO may be bound by an NP antecedent arbitrarily far up the tree, it cannot in general look arbitrarily far down the tree for its antecedent. In the contrasts in 3) and 4) below, the pronoun, but not PRO, may be coreferent with the antecedent embedded some clauses removed.

- 3 a) *PRO_i having shaved already shows that Mary arrived more than 5 minutes after John_i did.
- b) His_i having shaved already shows that Mary arrived more than 5 minutes after John_i did.
- 4 a) *PRO_i relieving himself from the night watch shows that the commander should have fired John_i.
- b) His_i relieving himself from the night watch shows that the commander should have fired John_i.

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A rough and somewhat too restrictive characterization of this constraint is that the antecedent of PRO must command it.¹ These contrasts would be inexplicable if PRO were acting here as a true pronominal, able to be freely indexed with any expression which it did not c-command.

3. More complex issues arise when considering aspects of the binding relationship itself, in addition to the domain in which an element must be bound. A number of properties hold of a given binding relationship: in 5) and 6), the anaphor must be bound in its governing category (6 a)), its antecedent must c-command it (6 b)), it does not allow split antecedents (6 c)), and it takes only one reading under VP deletion (6 d)).

- 5) John saw himself in the mirror.
- 6 a) *John_i said that Bill saw himself_i in the mirror.
- b) *John's_i campaign got himself_i elected.
- c) *John_i told Mary_j about themselves_{i,j}.
- d) John likes himself, and Bill does too.
 (only the bound reading: Bill likes Bill, not
 Bill likes John)

These properties, however, are of two distinct sorts. On the one hand, there is the fact that anaphors are necessarily referentially dependent, and must be bound within some local domain D (the governing category). The lack of inherent reference (Chomsky, 1981) may in fact be taken as a partial criterial definition of what it is to be an anaphor. The property of having to be locally bound (or locally co-indexed), henceforth called the dependency property of the anaphor, arises rather naturally out of the lack of inherent reference, and it is this which is specified in the Binding Theory. On the other hand, there is a set of properties--the ability to take split antecedents, the necessity for c-command, the number of readings under VP deletion--which more aptly characterize the binding relationship itself. Call these the binding properties of the binding relationship. The question then becomes: do each of these inhere equally in the element? In particular, is anaphorhood, in the sense of necessary referential dependence, necessarily linked with the set of binding properties mentioned above, or is the feature +anaphor only minimally specified for its dependency domain (its governing category), with the set of binding properties following as a consequence of the interaction of other modules in the grammar?

Recent work (Lebeaux 1982, 1983; Bouchard, 1982) differentiates local and nonlocal binding in terms of the set of binding properties characteristic of each. Define local binding in the following way (note that this usage is to be distinguished from the use of local meaning closest binder; it should perhaps preferably be called local-domain binding):

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- 7 a) A lexical anaphor is locally bound iff it is bound in the minimal NP,S containing it and its governor. Otherwise it is nonlocally bound.
- b) A nonlexical anaphor α is locally bound iff it is bound in the minimal NP,S containing γ and its governor, where γ is the minimal maximal projection containing α . (Cf. Aoun-Sportiche (1981) definition of c-domain; NP, S', VP, AP, PP maximal).

Instances of local binding are given in 8 a) and 9 a); instances of nonlocal binding in 8 b) and 9 b).

- 8 a) John saw himself in the mirror.
- b) John knew that there were pictures of himself inside.
- 9 a) John tried PRO to leave.
- b) John told Mary that PRO leaving early would be a mistake.

The division into local and nonlocal binding partitions the full domain in which an anaphor must be bound, its governing category, into two sub-domains corresponding to those in which local and nonlocal binding takes place. While overt anaphors are always bound within their governing category, they differ in the set of binding properties that they exhibit according to whether they are locally or nonlocally bound within this category. Thus an overt anaphor nonlocally bound may take split antecedents, may have two readings under VP deletion, does not require s-structure c-command of the antecedent, and so on. (See Lebeaux, 1983, for further discussion of the question of nonovert elements.)²

- 10 a) John told Mary that there were pictures of themselves inside.
- b) John thought that there was a picture of himself inside, and so did Bill. (picture of John, or picture of Bill: coreferent or bound reading)
- c) Pictures of himself please John. (no s-structure c-command)

A similar division of properties holds for locally bound and nonlocally bound PRO (note that this definition divides cases somewhat differently than Williams (1980) distinction between OC

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and NOC PRO.)³

- 11 a) John_i told Mary_j that (PRO_{i,j} accomplishing their end) would require care. (split antecedents)
- b) John knew that PRO leaving early would be disturbing to his kids, and Bill did too. (two readings under VP deletion)
- c) PRO having to get up early disturbs John. (no c-command)

Let us call the following set of properties f-binding properties (Cf. Koster, 1982): i) may not take a split antecedent, ii) require c-command, iii) take one reading under VP deletion. There are basically two ways of capturing the split in binding properties according to binding domain. One would be the following:

- 12) The f-binding properties are necessarily associated with the feature +anaphor. PRO is categorically ambiguous, +anaphor, +pronominal. The former feature is coindexed with the antecedent in local binding; the latter in nonlocal binding--the properties of the element follow from which feature is coindexed.

Under 12), the element is in essence a composite.

The alternative is given in 13).

- 13) PRO is an anaphor. The set of f-binding properties is not part of the meaning of "anaphor", the association of f-binding properties with local binding is due to the interaction of another module (to predication, in earlier work of mine).

The former proposal keeps dependency properties and binding properties linked, and thus requires a dual specification of the element (PRO and reflexives). The latter proposal divorces dependency properties from binding properties; only the dependency properties are associated with the anaphoric element. In contrast to 12) the element is minimally specified.

There are fairly strong conceptual reasons to prefer the

latter proposal to the former. Suppose that the element were composed of the features +pronominal and +anaphoric, and that each could freely enter into the binding. It would be expected, then, that if the +pronominal feature were used, it would not only carry with it "pronominal" binding properties, but would behave in other ways like a +pronominal feature--e.g. to be linked with NPs in arbitrary positions in the tree. However, it is precisely this that cannot be done.

- 14) * PRO having shaved already shows
 +anaphor/+pronominal;
 that Mary arrived more than 5 minutes after Joe_i did.

The element, then, is not truly decomposable: if one supposes that the feature +pronominal can freely enter into binding relationships, and that it is this which accounts for the binding properties, it still leaves unexplained why the dependency properties when this feature is bound to are not those of a normal pronoun. The dependency property of the element must remain constant, though the binding properties vary. This cannot be captured by positing a wholesale ambiguity.

4. We have been considering three possibilities for the featural status of PRO: a) that PRO is an anaphor, b) that PRO is +pronominal, +anaphoric interpreted disjunctively, or c) that PRO is +pronominal, +anaphoric interpreted conjunctively. Directly above, the disjunctive interpretation was found untenable since it did not provide a satisfactory explanation for the possession of "pronominal" binding characteristics in long-distance cases, together with a binding domain distinct from that for pronouns. Consider now what happens under the conjunctive interpretation of the feature set with respect to the element. That is:

- 15) All instances of PRO are a union of properties associated with +anaphoric and +pronominal.

With respect to the binding domain, a categorical status such as that in 15) would have the effects noted in Chomsky (1981). From the fact that incompatible binding properties would have to be attributed to the element because of its dual pronominal-anaphoric status, it was concluded that PRO had no governing category, that is was ungoverned (the PRO theorem). Assuming that PRO is ungoverned (though see Koster, 1980, Bouchard, 1982, and others) this result would be welcome, since it would follow as a consequence of the featural definition, and would not have to be stipulated as such. But consider what effect the definition in 15) would have on the determination of binding properties, if these were considered to be inherent to the features +pronominal and +anaphoric.

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- 16 a) By virtue of its +pronominal status, PRO allows split antecedents, lack of antecedent c-command, etc.
- b) By virtue of its +anaphoric status, PRO does not allow split antecedents, requires antecedent c-command, etc.

The two statements in 16) may not be satisfied simultaneously, in the simplest interpretation they result in a contradiction.⁴ In the case of the PRO theorem, a like contradiction could be avoided by giving up the assumption of a governor, but no such comparable move is available here. Thus if one were to assume that PRO is +anaphoric, +pronominal in the conjunctive sense above, it would still be the case that the f-binding properties could not be specified for the feature +anaphor without contradiction. I conclude, therefore, that binding properties are not specified for the element, nor for the features +pronominal and +anaphoric generally.

The arguments above remove one reason for assigning PRO dual status as a pronominal anaphor, since the possession of non f-binding properties by the element would no longer be taken to be criterial of its (partial) pronominal status. The position that PRO is a pronominal anaphor might still be maintained, but not jointly with the assumption that binding properties are associated with the features +pronominal and +anaphoric. The proposal above would leave open the question of how the split in binding properties would be accounted for. In connected work, beyond the scope of this paper, I have suggested that this would follow from the fact that cases of local binding, but not nonlocal, are bound in the course of predication, in the sense of Williams (1980). The claim is that the possession of f-binding properties is not linked to necessary dependence per se, but to the way in which an element is bound (Lebeaux, 1983).

5. All this leaves a large number of questions pending, however, if the status of PRO as a "pure anaphor" is to be maintained. The existence of arbitrary PRO, an apparently free element, is potentially an embarrassment; instances of PRO bound long-distance are likewise, under the natural--though perhaps erroneous--assumption that necessary dependence must involve the specification of some determinate binding domain. In this section, I will examine instances of so-called arbitrary PRO, coming to the conclusion that PRO in these cases is bound locally by a nonovert operator (cf. Chomsky (1981), Huang (1983), Heim (1982)). (See Chao (1983) for discussion from a somewhat different perspective.)

Consider the sentences in 17), in which S's with PRO subjects appear in both subject and object positions of a given verb.

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- 17 a) PRO making a large profit (as a slum landlord) requires PRO exploiting the tenants.
- b) PRO becoming a movie star entails/involves PRO being recognized by everyone.
- c) PRO winning this game requires PRO mastering the end game.
- d) PRO to know him is PRO to love him.

There is a peculiar restriction in the interpretation of the PRO_{arb}s in these sentences: while the reference of each PRO ranges over some universal set of entities (the domain restricted by context), the element picked out by the two PRO_{arb}s must be identical. Thus 17 a) means that for a given arbitrary person to make a large profit as a slum landlord, he or she must exploit the tenants. An appropriate representation of this reading would be 18), where a universal quantifier binds two open positions.

- 18) ($\forall x$ ((PRO_x to make a large profit) requires (PRO_x to exploit the tenants)))

No direct c-command holds between the two PRO's in the sentences above, so it cannot be the case of a direct binding relationship holding. This sort of restriction would be unexpected if the two PROs were truly independent. Note that the sentences in 19), with the arbitrary PROs distinct in domains that they range over would be perfectly meaningful.

- 19 a) *PRO becoming a movie star involves PRO recognizing you.
- b) *PRO to make a large profit as a landlord requires PRO being exploited (as a tenant).

The *'s here are taken to represent not ungrammaticality per se, but impossibility of the relevant interpretation. 19 a), for example would mean that for some arbitrary person to become a movie star, others, determined by context, must recognize them. 19 b) would mean that for a given landlord to make a large profit, others, the tenants, would have to be exploited. These interpretations would be expected to be possible, if the arbitrary PROs were not linked by being bound to a single quantifier.

Linked reference phenomena of the above sort holds where there is an obligatory subject position; in derived nominals, no linked reference of the "understood" subject is necessary.

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- 20 a) PRO winning games requires PRO losing games.
 (the winner and the loser must be the same:
 i.e., winning games requires the prior experience
 of losing games)
- b) The winning of games requires the losing of games.
 (the winner and the loser may be different: i.e.
 if someone wins, someone must lose)

The minimal contrast in 20)(p.c., Tom Roeper) exemplifies this, where the reference of the arbitrary subjects must be linked in 20 a), but not 20 b).

Similarly, abstract nominals do not require identity of their understood subjects, unlike the associated gerunds.

- 21 a) Wealth breeds/gives rise to envy.
 b) PRO being wealthy breeds / gives rise to PRO
 being envious.

Note, incidentally, that the referential linking of the two subjects in double gerund constructions is not by itself mandatory, if the subjects are lexical.

- 22) His getting up on time will require her setting
 the alarm clock.

It is possible as well to have a lexical NP in one gerund and an arbitrary PRO in the other.

- 23) The President said that PRO getting a tax rebate
 would require his signing the bill.

So no general parallelism constraint can be invoked.⁵

Facts like those in 17) strongly suggest that arbitrary PRO should be considered a bound element--in 17), bound by a universal quantifier binding both PRO's simultaneously, so that a linked reference reading can be gotten. The logical form given for the sentences in 17) is very similar to that given in the analysis of indefinites by Heim (1982). Heim suggests that an indefinite in an if...then construction may be construed as a variable bound by a universal operator, the restriction on the operator being given partly by the nominal head.

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- 24 a) PRO becoming a movie star entails PRO being recognized by everyone.
- b) $(\forall x ((x \text{ becomes a movie star}) \text{ entails } (x \text{ be recognized by everyone})).)$
- 25 a) If a man owns a donkey, he beats it.
- b) $((\forall x, x \text{ a man})(\forall y, y \text{ a donkey}) (\text{If } x \text{ owns } y, \text{ then } x \text{ beats } y))$

Like the donkey sentences, no c-command relationship holds between the two referentially linked elements in 24); like the donkey sentences, the class of predicates which allow the double universal binding of arbitrary PRO (requires, entails, etc.) involve a notion of necessity, which is supplied in 25) by the if...then construction itself. In addition, the lexical counterpart of arbitrary PRO when a case marking preposition like for is supplied is one, an indefinite. Let us then assume that arbitrary PRO is simply an indefinite--an anaphoric indefinite. As such, it shares properties with elements of this type, including that of being bound by an implicit universal operator in the appropriate contexts.⁶

Given that arbitrary PRO is bound, what is its binding domain? Define the binding category as follows (an approximation):

- 26) β is the binding category for arbitrary PRO iff
 β is the minimal NP, S' containing γ , where
 γ is the c-domain of PRO. (i.e. the minimally dominating S')

In the examples above, arbitrary PRO has always been bound in its binding category. In 24), for example, the binding category is the matrix S'.

The definition of a local binding category as in 26) makes a prediction: if two clauses containing arbitrary PROs are sufficiently removed from each other by embedding, obligatory linked reference can no longer hold, since different binders must be present to bind the PROs within their binding categories. This prediction is borne out by the minimal contrasts in 27) and 28).

- 27 a) $(S)_S (PRO \text{ having ancestors in the Old World})$
 doesn't make $(S)_S (PRO \text{ winning the West})$ any easier.)
- b) $(S)_S (PRO \text{ having ancestors in the Old World})$
 doesn't make (np) (stories about $(S)_S (PRO \text{ winning the West})$) any less interesting).

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- 28 a) $(S')_s$ (PRO winning the trust of the populace)
requires $(_s, \text{PRO having to serve in the army})$).
- b) $(S')_s$ (PRO winning the trust of the populace)
requires $(S')_s$ (that $(_s, (PRO having to serve in the army) be abolished))$)).

In 27 a) both PROs are arbitrary, but they are linked in reference; in 27 b) they are arbitrary but not linked. Similarly for 28 a) and b). This follows from the definition of the binding category. In 27 a) the binding category for the two PROs is identical, the circled S' , it is within this domain that the sentence is closed with a universal quantifier binding both PROs. In 27 b), the binding categories are distinct, the matrix S' for the first PRO and the embedded NP for the second. Hence different binders are required. In 28 b) the matrix S' is the binding category for the first PRO, and the embedded S' for the second, while in 28 a) they have the same binding category. In the latter, a single operator may bind both. In general, then, the local character of the linked reference phenomena supports the existence of a local binding domain.

The fact that NP's are protected from obligatory linked reference (27 b)) means that they are closed off in the way indicated. Since these categories do not have COMPs or a topic position, this suggests that the universal quantifier is not associated with either of these positions, but is simply adjoined to the category, in the standard position for quantifiers after QR: $(_{np} \forall x (_{np} \dots x \dots))$ and $(_s \forall x (_s \dots x \dots))$.

In the analysis above, arbitrary PRO is conceived of as being bound by an operator in an A' position associated with the dominating S . An alternative analysis might have it that arbitrary PRO is bound by an implicit argument associated with the matrix predicate. In 29), for example, arbitrary PRO would be bound by a position in the theta grid associated with the matrix predicate difficult.

- 29) PRO to leave early would be difficult.

This proposal is similar to the one just given in that in both cases arbitrary PRO is analyzed as bound. However, there is some evidence that it does not cover the full range of arbitrary PROs.

- 30 a) What PRO to do is unclear.
b) John likes stories about PRO bettering oneself.
c) In this prep school, PRO eating by oneself is highly disapproved of.
d) PRO to know him is PRO to love him.

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In 30 a) and c), the nonovert argument of the matrix predicate does not match that of PRO (30 a), for example, may mean that what one should do is unclear to me); in 30 b) and d), there is no implicit argument to bind the PRO. All of this suggests that arbitrary PRO must have at least the option of being A' bound by an element at the clause level; I will assume that this is generally the case.

6. In the preceding section, the identity of reference of arbitrary PROs in the "double-binding" constructions above was traced to the existence of a higher binder, rather than some direct relation established between the two PRO positions themselves. This sort of analysis allows for a very natural characterization of the positions in which arbitrary PRO, and long-distance bound PRO, are possible as well.

Let us make the assumption that arbitrary PRO is not a distinct element from lexically bound PRO, but simply a PRO which has not found a local antecedent, and so is bound by an operator in the manner suggested above. The binding category 26), repeated here, would then be expected to be in force for the binding of PRO, as well as PRO_{arb}.

- 31) PRO must be bound in the minimal NP, S' containing δ , where γ is the minimal S' containing PRO.

In addition, we would like to account for the fact that an arbitrary PRO reading is in general available only when a lexical antecedent is not present within the local domain. This may be done by formalizing the intuition that PRO searches for an antecedent within its local domain, and if no such antecedent is present, an operator is inserted to locally close off the sentence. This operator, in turn, may be restricted in reference by coindexing with some lexical antecedent (Chomsky, 1981), or may be left antecedentless, in which case its reference is free, and an arbitrary reading results (generally represented with a universal quantifier above). A preliminary version of the binding theory for PRO would be the following:

- 32) Binding category: β is the binding category for PRO if β is the minimal NP, S dominating γ , where γ is the minimal S' dominating PRO.
- 33) Closure: If PRO is unbound in its binding category, adjoin e_i coindexed with PRO_i to the binding category.
- 34) Operator interpretation: An e in an A'-position, not bound by an A' antecedent, is construed as an operator O (cf. Levin, this volume). If O_i is coindexed with an antecedent NP_i, interpret it with the reference of that NP. Otherwise, interpret it as free (i.e. arbitrary), or, in marked cases, with a pragmatically picked out referent.

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A few features of 32)-34) require comment. The binding category has changed from the formulation in 31) from the matrix S' to the matrix S. The PRO searches for an antecedent within that domain, and only if no such antecedent exists is the sentence closed off. The appearance of the operator is assumed to arise through insertion rather than movement, though the analyses would be very close, and in particular would have identical outputs. Insertion of an element with a nonidentical subscript would be ruled out, since in that case the empty element in A-position would remain unbound, and by a general constraint against open sentences be filtered out.

The formulation of the binding category for PRO above is far from complete, but would account for a significant subset of the data.

- 35 a) *John would like PRO_{arb} to leave.
 b) *John often leaves without PRO_{arb} really wanting him to.
 (cf. John often leaves without one really wanting him to.)
 c) *Bill_i said that John often leaves without PRO_i really wanting him to.
 d) John_i admitted it was uncalled for PRO_i to buy himself that.
 e) PRO having ancestors in the Old World didn't make PRO winning the West any easier. (linked reference)
 f) PRO having ancestors in the Old World doesn't make stories about PRO winning the West any less interesting. (no linked reference)

In 35 a), PRO cannot be arbitrary because a possible antecedent, John, exists within the binding category. In 35 b), PRO again cannot be arbitrary because a possible antecedent exists within the binding category; note that there is nothing excluding the nonanaphoric indefinite in the subject position of the without- clause. In 35 c), the long distance binding of the PRO is impossible for the same reason. In 35 d), there is no lexical antecedent within the binding category, so an operator is inserted at its periphery, binding the PRO. The operator itself may be left without an antecedent, or may be coindexed with John, restricting its reference.

- 36 a) John admitted that (O_i(it was uncalled for (PRO_i to buy oneself that))).
 b) John_i admitted that (O_i(it was uncalled for (PRO_i to buy himself that))).

The contrast between 35 e) and f) also follows, as already noted in the text.

If the general approach sketched above is correct, than the role of control stipulations in control theory may be radically reduced. The nonexistence of an arbitrary PRO reading in examples like 35 b), and the contrast in control in 38), would not need to be asserted by some special control rule to that effect, but would follow from the general principle that PRO, an anaphor, searches for an antecedent in its local domain, and an arbitrary reading, or long distance control occurs only when that search fails.

37) *John often leaves without PRO_{arb} really wanting him to.

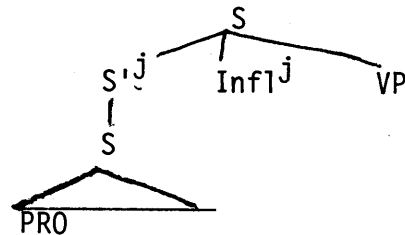
38 a) It is unclear what PRO_{arb} to do with oneself in this town.

b)?*John is unsure what PRO_{arb} to do with oneself in this town.

In examples like 37), unlike the standard cases of control into a subcategorized complement, there is presumably no property of the argument structure of the matrix sentence which picks out some particular element as the controller--the subject always serves that function, as the only c-commanding antecedent within the relevant domain. More generally, the lexical-semantic properties of control which involve choosing some particular element in the matrix clause as the antecedent of PRO, and which would have to be specified verb by verb, would be distinguished from the necessity that PRO have a local antecedent, which follows simply from its status as an anaphor. In some cases, the verb complement cases, the binding of PRO is jointly determined by principles of argument structure and its status as an anaphor; in other cases, such as 37), control properties should not be specified by the matrix verb, but would follow from PRO's anaphoric status.

The approach given above is similar to that of Manzini (1983) in that in both cases a local domain (in her case a domain-governing category) is picked out within which PRO must be bound. In configurations like 39), in Manzini's account, PRO does not have a domain-governing category since there is no accessible subject, and so PRO is allowed to refer freely.

39)



In the account above, like configurations are characterized by the existence of a nonovert element binding the PRO.

- 40) (O_i ((PRO_i to walk ones dog) requires great agility)).
 41) (O_i ((PRO_i to walk ones dog) is highly illegal)).

The chief conceptual difference in the two accounts is that I am assuming that PRO must always be bound--this would follow from its anaphoric status, taken as requiring an antecedent, as well as any general constraint barring open sentences. Empirical differences flow from the existence of this binder: it allows, for example, an account to be made of the double-binding constructions discussed above, which would require some additional apparatus if such a binder is not assumed. In addition, the PRO in constructions like 39) is not simply free in reference. As noted in section 2, pronouns, but not PRO, may be coindexed with elements arbitrarily far down the tree.

- 42 a) *PRO_i having shaved already shows that Mary arrived more than 5 minutes after John_i did.
 b) His_i having shaved already shows that Mary arrived more than 5 minutes after John_i did.

This would follow from the constraint on the distribution of O_i :

- 43) O_i may not c-command its antecedent.

43) would obviously be stated in terms of the position of the operator, and not that of PRO. (See Sportiche, 1983, for an analysis from a somewhat related point of view.)

7. I will close by noting some effects--crossing effects--which characterize instances of long-distance binding of PRO.

Consider cases of the long-distance binding of PRO.

- 44) John and Sue_i thought that Mary had said that it would be illegal PRO_i to buy each other out of that jam.
 45) Steve_i wondered if Mary had said that PRO_i buying himself that stereo had been a mistake.

As argued above, PRO could not be directly bound by the antecedent here, but must have a local A'-operator.

- 46) John and Sue_i thought that Mary had said O_i that it would be illegal PRO_i to buy each other out of that jam.
- 47) Steve_i wondered if Mary had said O_i that PRO_i buying himself that stereo had been a mistake.

The O_i here is an operator in the sense used by Chomsky (1981) as an A' element which acts as a binder. We may assume either that O_i gets its reference directly from the antecedent, or that there is a chain of elements (O_i, e_i, PRO_i) where the head of the chain is co-clausal with the ultimate antecedent, and gets its reference by coindexing with it.

- 48) John_i wondered O_i if Mary had said e_i that PRO_i buying himself that stereo had been a mistake.

In either case, the apparently unbounded dependency between John and PRO would actually be composed of two parts: an A' chain (O_i...PRO_i) and the antecedent John. The latter would be coindexed with the former, restricting its reference, in a fashion familiar from analyses of relative clauses and tough movement. (Chomsky, 1981, 1982).

The domain of crossing effects may now be stated.

- 49) Let O_i be an operator which locally binds PRO_i, and let NP_i be the ultimate NP antecedent. Then for any two pairs (NP_i, O_i), (NP_j, O_j), the paths generated by these pairs must be nested.

This is the formulation in terms of paths through trees, another formulation may be stated in terms of (sub-) chains.

- 50) Let O_i be the operator which locally binds PRO_i, and let NP_i be the antecedent with which O_i is coindexed. Let NP_j, O_j be a similar such pair. Then NP_i c-commands NP_j iff O_j c-commands O_i.

Some examples of this are given below. The relevant contrasts are in two directions: the long distance binding of PRO vs. that of pronouns, and nested long distance binding of PRO vs. crossing long distance binding. (For momentary expository convenience, I will draw the "linear" version of the constraint.)

ANAPHORIC BINDING AND THE DEFINITION OF PRO

51) $Mary_i$ knew that $John_j$ thought O_j that PRO_j killing himself would show O_i that PRO_i leaving him had been a mistake.

52) * $Mary_i$ knew that $John_j$ thought O_i that PRO_i killing herself would show O_j that PRO_j leaving her had been a mistake.

In each sentence there are two long distance antecedent-PRO dependencies, but in 51) they are nested and in 52) they are crossed. Computational difficulties with sentences of this complexity aside, there appears to be a marked difference in grammaticality between the two, with the latter not well-formed. Note that it is the crossing effect of the two PRO dependencies which is relevant here; if we eliminate one of the dependencies, or supply pronouns, the sentence becomes grammatical.

- 53 a) $Mary_i$ knew that $John_j$ had said O_i that PRO_i killing herself would be frowned upon.
- b) $Mary_i$ knew that $John_j$ thought O_i that PRO_i killing herself would show that his leaving her had been a mistake.

Another example of the same type is given below.

54) $John_i$ wondered if $Mary_j$ thought O_j that PRO_j telling him about the dangers would make real (O_i the difficulty of PRO_i climbing by himself). nested.

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- 55.) *John_i wondered if Mary_j thought O_i that PRO_i
 telling her about the dangers would demonstrate
 (O_j the difficulty of PRO_j climbing by herself).
 crossed.

Again, the sentence is improved if pronouns are supplied or the last PRO is eliminated.

- 56 a) John_i wondered if Mary thought O_i that PRO_i
 telling her about the dangers had been silly.
 b) John_i wondered if Mary_j thought that his_i
 telling her about the dangers would demonstrate
 the difficulty of her_j climbing by herself.

The grammaticality judgements are my own, but they seem generally shared. At a gross level, the crossing effects are sufficient to show that the long distance binding of PRO is not equivalent to the binding of overt pronouns, which show no such effects. More particularly, the crossing constraint must be stated with reference to the position of the posited operator, and not directly in terms of the path between the ultimate antecedent and PRO. This is because even in the grammatical "nested" cases such as 51), the representation would not count as nested by path theory if PRO were taken as the terminal point: the path between John_i and PRO_j in 51) would have a spur leading off to the gerund not included in the longer path. Similarly, with respect to the formulation in 49), no set of c-command relations would exist: PRO_j does not c-command PRO_i even in the nested case--unlike the situation with the associated operators. This provides an interesting, though rather indirect, argument for the existence of such operators. Other evidence may be available from the interaction of the long distance binding of PRO with other instances of A'-dependencies (in particular, wh-movement), though I will not attempt any discussion of that here.

7. The analysis above has examined certain consequences of assuming that PRO is a necessarily dependent element, an anaphor, in the grammar. The claim required, on the one hand, a re-analysis of certain constructions in which PRO is apparently free (instances of arbitrary PRO), and others in which PRO is bound long distance. Arbitrary PRO was analyzed as a bound element, bound by a nonovert operator associated with the matrix clause; this analysis in turn was compatible with the idea that arbitrary PRO is an anaphoric indefinite, where indefinites may ultimately be analyzed along the

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lines suggested by Heim. Evidence for the fact that arbitrary PRO is bound came from the analysis of double gerund constructions; these were also shown to have the property that necessarily linked reference was restricted in domain, hence supporting the existence of independent binders for these cases and thus for a local binding domain for the arbitrary PRO. Some evidence regarding crossing effects for the long distance binding of PRO pointed in the same direction.

At a more abstract level, the proposal that PRO is an anaphor (a "pure anaphor") required an evaluation of what properties should be held to inhere in the notion of "anaphor," and in particular of whether necessary dependence was intrinsically linked with the possession of f-binding properties. Such properties were taken not to be linked to the element itself, but rather to the domain of the binding.

FOOTNOTES

¹There are well-known counterexamples to the command restriction.

- 1) PRO learning math is important for the children's development. (Chomsky, 1981)
- 2) PRO to see Mary is a thing that I think that John enjoys.

There is little to say at present about the equative construction --note that the same structure allows the binding of overt anaphors.

- 3) Those pictures of each other are things that John and Mary enjoy.

Presumably what is necessary is a theory of "connectedness" phenomena, in the sense of F. R. Higgins.

²The question of intermediate elements is a complex one, which I cannot hope to do justice to here. One piece of evidence that there is no intermediate element in the subject position in examples like 8) is that the interpretation of such NPs is not that which would be expected if such an element were present. E.g. 4), where the pictures are pointedly not Jackie's.

- 4) Jackie knew that some pictures of herself had been taken, without her knowing.

If one were to assume that there were a PRO in the subject position of the NP, it would be necessary to allow it to have no effect on the interpretation of the noun phrase.

Further, in 5) the reflexive allows split antecedents, though there is no apparent place for an intermediate element to be.

- 5) John told Mary that as for themselves, they should leave early.

³As noted by Sportiche (1983), a three way distinction is almost certainly necessary here.

⁴Whether this results in a contradiction or not depends on whether the +pronominal feature is positively specified for the set of characteristics in 16 a) (in which case a contradiction would result), or is simply unspecified. In the latter case, the union of binding characteristics of the two features would be the more restrictive set--that belonging to the +anaphor feature. That still would not achieve the desired result of having the element behave, with respect to the binding properties, as if it were sometimes a pronominal.

⁵A different sort of potential counterexample has been brought to my attention by E. Williams, an example originally due to Montague.

6) To love is to adore.

Both the subjects and the objects must be referentially linked in 6), suggesting some sort of general constraint or nonovert elements being parallel.

However, choosing different predicate, we note that (although all sentences are a little odd), identity of reference is required of the subject, but not the object, when they are left alternately nonovert.

- 7 a) To love Mary would require to adore John (same person).
- b) For Mary to love would require for John to adore (can mean: for Mary to love John would require for John to adore Mary).

⁶In Heim's theory, the universal reading is gotten by the introduction of a nonovert necessity operator, that is inserted in the course of deriving logical forms from syntactic representations. The necessity operator functions like "must", which corresponds to universal quantification over the elements it binds.

Some support for the idea that universal quantification is associated with a nonovert necessity operator is available in the sentences under consideration here. When the matrix predicate does not involve necessity, the forced universal double binding disappears.

- 8) PRO going to the movies beats PRO staying home and PRO eating popcorn.

Here, as in other cases noted in the text, PRO is unspecified: it does not carry with it the quantificational force of the operator binding it, but this is supplied by context.

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