Binding in the DP and Index Percolation

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ABSTRACT

The purpose of this paper is to discuss data bearing on the application of the binding theory to Abney's (1987) DP analysis framework. Difficulties using the complete functional complex version of the Binding Theory (CFC BT) will be reviewed, and it will be shown that their resolution lies in assuming an empty category subject in the NP. From this starting point, binding within the determiner phrase (DP) is discussed and several structural issues are raised, one being that any explanation of binding in the DP needs to account for the fact that the addition of the DP node above the NP causes the standard binding theory to make incorrect predictions. The interaction of
the binding theory and the DP structure forces the conclusion that referential indices must percolate upward in the phrase marker by a mechanism of index percolation and formalized rules governing this process are put forward in line with Cowper’s (1987) theory of percolation. The empty category subject of DP is examined and found to behave similarly to PRO in the IP. Difficulties concerning the control of PRO in the DP are also considered.

(KEY WORDS: C-Command; Complete Functional Complex; Binding Theory; DP analysis; Percolation; Control of PRO)

I. INTRODUCTION: NP Picture Reflexives aren’t Correctly Predicted

The Complete Functional Complex Binding Theory (CFC BT) and other variants proposed by Chomsky [1-2] (for a summary, Lasnik, [3]) cannot account for the distribution of anaphors in sentences where there is apparently no c-commanding antecedent to bind them. NP picture reflexives, as in (1) are a particularly troublesome case for Principle A of the theory because the anaphor’s “antecedent” is frequently located in object position in the matrix clause:

1) Pictures of himself, embarrass John.

Here, the NP John is far enough down in the phrase marker that it cannot bind the anaphor himself. The definition of c-command cannot be weakened enough to allow this antecedent to bind its anaphor, for as Freidin [4] points out, to do so would mean allowing any object in sentences of structure (2) to control into the subject position. This has the unwanted result of predicting sentences like (2) to be grammatical because the illegal anaphor would be bound and coindexed by an ‘antecedent’.

2) *Themselves, saw the men.

The ill-formedness of sentences of type (2) indicate that changing either the definition of bound (Chomsky [1]) or c-command (Reinhart [5]; Aoun and Sportiche [6]) will cause the theory to overgenerate. We must assume that this option is not open to us.

At this point it may be instructive to take a look at how the binding theory actually applies to NP picture reflexives and the trouble it encounters. The CFC BT states that to be licenced an anaphor must be bound in the least CFC that contains it. To determine the least CFC in which the anaphor (A) needs to be bound we need to find three things:

i) the governor of A
ii) a subject
iii) a possible indexing J for A

First, take sentence (3):

3) John, hates pictures of himself.

The first requirement is easily found. Himself is governed by the preposition of. The second re-
requirement is slightly more difficult. There is no subject of the NP *pictures*, therefore, the NP cannot be the least CFC. This forces us to look to the next larger CFC. The matrix IP does have a subject, and this would suggest that it is the minimal governing category (MGC), assuming we can find a possible indexing J for the anaphor. The r-expression *John* binds the anaphor within the CFC, meeting the third requirement. Since the IP is the least CFC, and the anaphor is bound in IP, it is licensed and the sentence is predicted to be grammatical. But take the NP picture reflexive in sentence (1) repeated here for convenience.

1) Pictures of himself, embarrass John.

The first two criteria are met the same way as in (3). The anaphor is governed by P, and since there is no subject of the NP and the matrix IP has a subject, the IP is the least CFC. But at this point the theory begins to flounder. In order for the anaphor to be licensed it must be bound under some indexing J within the least CFC. There is no indexing J possible on which the anaphor could be bound. Since no such indexing exists, and as shown above we cannot claim that *John* binds himself, the sentence will be incorrectly predicted to be ungrammatical. However, there are two options available to obtain the correct prediction:

i) the licensing condition does not apply

ii) the anaphor is coindexed to some unknown element that binds it.

Option (i) has two serious flaws in its application: the necessity of forcing an i-over-i violation and the overgeneration allowed when the licensing conditions do not apply. First, consider the sentence structure in (4i). The embedded IP has a subject *pictures* and an anaphor *each other*, but the anaphor is not bound in this CFC and would incorrectly be labelled unlicensed.

4i) The children thought that [IP[NP pictures of each other] AGR were on sale}

ii) 

![Diagram](image)

A way of saying that the next larger CFC is the MGC is needed. Both Freidin and Chomsky allow the ‘imaginary’ coindexation of an NP-dominated NP like *each other* in structure (4ii) with AGR. Since the lexical item in subject position of the clause is thought to be coindexed to AGR already, this would result in an i-over-i violation because the dominated NP takes on the same coindexation as the dominating NP. The whole point, therefore, of allowing this imaginary coindexation is to force
an i-over-i violation. When this forced i-over-i violation occurs, the theory stipulates that the phrase or clause being tested cannot be the MGC. In (4ii) we can see that the NP pictures is coindexed with the agreement element in INFL. Coindexing each other with AGR subsequently produces an i-over-i violation and the next larger binding domain must be used. With this in mind we would rule out the embedded clause in (4ii) as the minimal governing category. Thus, we are forced to look for a larger CFC, namely the matrix IP. The anaphor is indeed bound by the NP children in this CFC and consequently, licensed. However, while coindexing the dominated NP to AGR produces the desired results, this mechanism is arbitrary at best. Take for instance (1).

1) Pictures of himself; AGR embarrass John.

Here, no possible coindexation can be construed between AGR [+PLURAL] and himself [−PLURAL]. That the arbitrary indexing between an NP-dominated NP and AGR cannot occur in (1) throws serious doubt on the validity of the process and again we are left with no way to explain this structure.

The second difficulty with option (i) arises from the stipulation that in some structures the licensing conditions do not apply. Since the NP pictures in (1) has no subject, we must look for the next larger CFC which is the IP. However, the anaphor is not bound within IP. If an i-over-i violation were invoked (following the course of action we used in the analysis of (4ii) above), we would be forced to look outside the IP for the least CFC, which is impossible since IP is the largest domain. At this point we could claim that since there is neither a least CFC nor a BT compatible indexing J, the licensing condition does not apply. This will produce the correct judgement of grammaticality for example (1), but also allows overgeneration. We would now not be able to rule out sentences of type (5):

5i) *Pictures of themselves would please the boys,
ii) *Pictures of himself, annoy Sally.

Another way to tackle the problem is to assume that the outcome of the discussion on coindexation between AGR and an NP-dominated NP is correct, and there is no i-over-i violation in (1) or (4). But deleting the mechanism that forces an i-over-i violation and the stipulation about when the licensing conditions are valid causes problems. Under this interpretation, in sentence (1) the matrix IP would be the least CFC. Because the anaphor is free in this environment, it is unlicensed and the sentence will now be judged to be ungrammatical. In (4) the embedded IP must now be the least CFC and as the anaphor is not bound in this domain, the sentence is also incorrectly predicted to be ungrammatical. By deleting these arbitrary mechanisms we have actually weakened the standard theory in that it now makes incorrect judgements for (1) and (4) where previously it made correct judgements. In short, leaving the coindexing to AGR mechanism in the theory causes the CFC BT to overgenerate, while taking it out causes undergeneration.

Option (ii) above presents us with a simple and at first sight appealing alternative. There may be an empty category subject of NP. The appropriate S-structure of (1) is in (6).

6i) e, pictures of himself, embarrass John,
If this is the case, the NP in Spec of IP becomes the least CFC because it is in this domain that the anaphor is governed, has a subject, and finds a BT compatible indexing J. And since the anaphor is bound, it is licensed in accordance with Principle A. This alternative greatly simplifies the application of the binding theory to NP-picture reflexives.

II. DISCUSSION: There is No Structural Position for ei

Section 2.1: Where is ei?

While we have seen that the appearance of an empty category in subject position in the NP can explain certain binding facts that otherwise remain puzzling, it also causes further problems. There is no place for such an element to appear in the standard structure. Chomsky [2] suggests that PRO might appear in the specifier position of the NP as in (7), but this seems an unlikely site for PRO because we are then unable to find a site for the determiner. Under Chomsky's interpretation it seems that both PRO and a determiner may occupy the same position in the same phrase marker as in (8).

7)  
   NP
     /\  
    /   
   NP  N'
     / \  
    PRO N

8)  
   NP
     /\  
    /   
   NP  N'
     / \  
    PRO N

If we take this to be true, then we have to admit that the spirit of X-bar theory is violated in that each of the lexical elements does not have a maximal projection. What is apparently needed is a more sophisticated structure of the NP with positions for both an empty category subject and a determiner. Abney [7] provides a theory giving the noun phrase more structure than has been traditionally believed. On the grounds that the NP and sentence are parallel in many ways, he suggests that the determiner is a functional element (D) that heads the NP in much the same way that INFL is the head of the sentence. This functional element has DP as its maximal projection. In this fashion there are positions for both an empty category subject and a determiner. This gives us the structure in (9)*.

9)  
   DP
     /\  
    /   
   NP  D'
     / \  
    (e) D  NP
      / \  
     (the) N  N'

*I have slightly modified Abney's structure in that I have included the maximal projection NP where abney only uses N'. The reason for this being that it is generally accepted that only full NPs can be indexed to one another.
Having an empty category subject within the determiner phrase (DP) structure allows the binding theory to make the correct prediction about the grammaticality of (1) represented here as (10). Because the DP has a subject, it is the MGC, and the empty category subject binds the anaphor within the MGC in accordance with Principle A.

10) [sp [dp c, [np Pictures of himself]]] embarrass John.

This elegant solution is successful where the standard interpretation of NP picture reflexives without an empty category subject fails.

Chomsky [2] suggests that an empty category (PRO) can appear optionally as the subject of NP. One motivation for this is to explain why the complementary distribution of anaphors and pronominals is broken by sentences like (11).

11i) The children heard stories about each other.
   ii) The children heard stories about them.

In (11i) the least CFC is the matrix IP, assuming the standard NP structure. It is within this MGC that the anaphor must be bound. Since this is indeed the case, the CFC binding theory correctly predicts the sentence to be grammatical. However, under this interpretation of the facts, the MGC would also be the matrix IP for them in (11ii) which means that the pronominal would be bound, incorrectly predicting the sentence to be ungrammatical. Again, this problem is solved if there is an empty category subject of DP, as in (12).

12i) The children heard [dp c, [np stories about each other]]
   ii) The children heard [dp c, [np stories about them]]

In this representation, the least CFC is the DP e stories. If, in this MGC, e and the pronominal them are disjoint in reference, the CFC BT makes the correct prediction of grammatical, see (12ii). As long as the indices are identical, the anaphor in (12i) will also be licensed. Under this interpretation the anaphors and pronominals are in complementary distribution because their antecedents occur under different indices within an otherwise equivalent structure.

Thus, using the structure provided by the the DP analysis we can increase the explanatory power of the CFC binding theory to handle the previously troublesome NP picture reflexives and the non-complementarity of anaphors and pronominals by adding an empty category subject which enters into a binding relation with the anaphor or pronominal. The DP analysis allows the postulated empty category to occupy a very natural position as subject of DP.

Section 2.2: Binding Using the DP Analysis Forces Index Percolation

Despite the added ability to predict the grammaticality of NP picture reflexives, there are difficulties using the binding theory within the DP framework. One problem for the DP analysis is immediately observable in sentences of type (13). If all noun phrases are DPs and an empty category is always present when there is no overt subject, then (13) might have the underlying form in (14).

13) *I cut myself,
14) *I cut myself.

If this were the case, (13) would be predicted to be grammatical by the binding theory. But other data argues that pronouns do not have a DP structure. Unlike other noun phrases pronouns cannot take a specifier, as can be seen from (15).

15) *He cut the himself.

This fact suggests that they are simply NPs. Given this, (13) no longer presents a problem because the least CFC is the matrix clause, and the anaphor is not bound in violation of the binding theory.

A second and more serious problem posed by using binding principles in the DP analysis is that sentences of type (16) are no longer considered grammatical by the binding theory.

16) [sp The boy] expected himself to win.

This is because with the addition of the DP node, the Np the boy no longer c-commands (or m-commands) the anaphor. This fact remains the same whether or not we postulate an empty category in the spec of DP. This means that any account of binding using the DP structure will have to overcome this difficulty regardless of the nature or existence of an empty category subject of DP. A similar situation obtains in sentences (17) and (18).

17) [sp The pictures of John] sold themselves.

In (17), which is the standard representation, the NP pictures c-commands the anaphor that refers to it, but in (18) the NP pictures no longer c-commands the anaphor because of the intervening DP node.

If we follow Chomsky's [1] claim that NPs can freely index with one another, then we still want to claim that these two NPs in (18) are coindexed. Since the sentence is grammatical, Principle A must be able to license the anaphor, and yet there can be no c-command relation between the anaphor and its antecedent because of the intervening DP node. Further, we have argued earlier (see section I) that the definition of c-command cannot be changed to accommodate the facts. This leaves us with two possible alternatives if we are to extend binding to the DP analysis, either the phrase marker collapses, as in complementizer contraction, or the referential index instantiated on an NP must perco-
late upward through the structure to the DP. I have chosen the latter view.

18) \[ \text{IP} \rightarrow \text{[NP e the pictures of John]] sold themselves.} \]

The next question to ask is: if the referential index percolates, how does it do so? If the DP were a projection of N, this would be easy to explain, because we assume that a maximal projection has all the features of its head. In fact, Abney [7] seems to assume something of this nature when he claims that the DP should be thought of as NP. But we don’t want to claim that DP is a projection of N, since it is actually a projection of D. We are forced to conclude that the referential index on NP percolates up to the DP so that it in effect acts like the maximal projection of N. A rough and ready hypothesis would possibly be that the referential index on an NP inside a DP simply percolates upward. This mechanism can be used to make predictions for the binding theory.

After percolation, the DP in (18) will now bear the indexing mark from the NP pictures, and hence the DP will be able to bind the anaphor since it both c-commands it and bears an identical index. Since the anaphor is now bound in its least CFC, the binding theory predicts the sentence to be grammatical. Such a general hypothesis quickly comes across counter-examples like (19) where the indexing on the NP John must not be allowed to percolate to the DP or it will incorrectly bind the anaphor and allow the binding theory to make an incorrect judgement of grammatical.

19) \[^{lit} \rightarrow \text{[NP e pictures of John]}] embarrass himself[\]

It would appear that a mechanism restricting the percolation of referential indexing is necessary. It is my contention that Cowper’s [8] mechanism for feature percolation can be adapted to serve this purpose. This mechanism is itself adapted from the morphologically oriented percolation in di Sciullo & Williams [9]. Cowper proposes a syntactic version of the percolation of lexical features to explain certain facts about pied piping. She posits two main rules that govern the percolation of these features. Roughly stated, they are:

i) The features on a head have precedence for percolation over like features on a complement.

ii) When a head is undefined for a certain feature which exists on a complement, the feature on the complement will percolate upwards.

We could think of index percolation in terms of such features as \([+ / \sim \text{animate}]\) or \([+ / \sim \text{animate}]\)
plural], but in the end it must be admitted that these features are irrelevant to the binding theory. Since the binding theory operates by judging the binding relation between two elements, we crucially want the indexing mark itself to percolate. The movement of the indexing mark from one position in the structure to another might of course entail the movement of features along with it. But in fact no lexical features need percolate at all, as it is the referential indexing itself which is used to determine the binding relationship. For our purposes percolation can be defined entirely in terms of the referential index. Given this, Cowper's rules may be rewritten for binding as follows:

20) Index Percolation Within the DP:

i) The index on a head has precedence for percolation over the index on a complement.

ii) When a head bears no referential index, the indexing on a complement can percolate upward.

These simple rules fall out in part from X-bar theory itself because we assume that a maximal projection bears all the characteristics of its head simply because it is a projection of that head. Note that such a theory might predict that referential indexing actually occurs at the level of the head, not the NP. I would like to propose an adaptation of Cowper's formalism:

21) Index Percolation in DP formalized:

In a structure [λ BG] or [λ GB], A a projection of B, the index from G will percolate to A iff B is not indexed, otherwise the index on B percolates.

Sentences (18) and (19) are now easily explainable. Consider (18) represented as (22) below.

22) [wp [np [np e the pictures of John]] sold themselves,
In (22) the indexing instantiated on the NP *pictures* by the free indexing rule in Chomsky [1] will percolate to D¹ because the head D is not specified for any referential index. From there the indexing (i) will percolate to DP. Now the DP can bind the NP *themselves* and the sentence will be correctly be judged grammatical by Principle A. Since the anaphor is bound in the least CFC, the IP, it is licensed. Now consider (19) represented here as (23).

23) *_[[dp e pictures of John] embarrass himself]]*

In (23) the referential indexing on the NP *John* can percolate to the P¹ level and eventually the PP level. At this point it is blocked from going any further because PP is sister to a head with an index instantiated on it. Since the head N is already specified for the index (i), it has priority over the index (j) and (i) percolates to its maximal projection, the NP. From there the indexing (i) makes its way to D¹, because D is unindexed, and is finally instantiated on DP. In this sentence the least CFC for the anaphor is again the matrix IP. Hence, the anaphor must be bound in this domain, but since the DP bears an (i) indexing it cannot bind the NP *himself* which bears the (j) index. Since the anaphor remains free in its domain, the sentence is correctly predicted to be ungrammatical.
Section 2.3: Control and the Nature of the Empty Category

That there is a control relation between the matrix subject and PRO is apparent from examples like (24).

24i) John promised Bill PRO, to go
   ii) John persuaded Bill, PRO, to go

In both cases PRO is controlled by a c-commanding antecedent. Which antecedent does the controlling is determined by the verb and in this sense is determined by lexical information. In these instances, control of PRO is obligatory. In (24i) for example the sentence cannot be interpreted to mean that Bill was going and certainly cannot have the meaning that someone other than John was going. A similar state of affairs seems to hold concerning the assignment of reference to the empty category in a DP. Let us assume for the moment that the empty category is indeed PRO and we are dealing with rules of control (for further discussion of PRO in the noun phrase see Abney [7]: 92 and 105 regarding theta theory; Chomsky [2] for evidence from Principle B; Roeper [10] for evidence from control theory; and Ross [11] concerning Principle C. For opposing views see Williams [12]). Under the claim that there is a PRO in the DP, the binding theory would predict (25i) to be grammatical since the anaphor is bound in the least CFC.

25i) John found PRO, pictures of himself
   ii) *John found PRO, pictures of herself

But (25ii) would also be considered grammatical for the same reasons. To rule out this possibility, it is necessary to enforce a subject control of PRO, (see also, Roeper [10]; Manzini [13]) so that (25ii) is rendered ungrammatical. This might lead us to believe that control is obligatory in the DP in the same sense that it is in IP with a verb like promise. But the postulation of such a rule of control is confounded by pairs like (26i and ii). These sentences stem from the solution to the noncomplementarity problem discussed in section 2.1.

26i) The children heard PRO, stories about them
   ii) The children heard PRO, stories about themselves

In (26i) PRO must be disjoint in reference from the subject, while in (26ii) it must be coreferent with the subject. We can no longer claim that control in the DP is determined only by c-command and lexical information from the verb because in (26) the phrase marker and the verb are the same for both sentences, and yet, in one the embedded subject must be controlled by the matrix subject and in the other it cannot be. In the absence of a specific rule of control it could be claimed that the ungrammatical sentences in (27) would be discarded by a syntactic processor because they violate binding and hence would never be produced by the fluent speaker.

27i) *The children heard PRO, stories about them
   ii) *The children heard PRO, stories about themselves

Chomsky’s [2] claim that the empty category is optional and hence would not appear in (26ii or 27ii)
might also be used, but this seems rather unappealing and has problems of its own. In addition, (27i) would still remain unexplained. If PRO is the empty category subject of DP, then it is apparent that rules of control in the IP and DP are different.

Aside from control, there are two further difficulties presented by an assumption that the empty category subject of DP is PRO—Spec DP must be a caseless position and PRO must receive a theta role from somewhere. The first condition is easily met while the second causes some difficulty when using the DP analysis. Since no genitive morphology appears in (26) it can be argued that D is not case marking Spec DP and the position is therefore ungoverned, meeting the first condition and opening up the way to claim that PRO is possible in the position. As for the second condition, D assigns a possessor theta role to the Spec of DP, but only does so when genitive morphology is present on the surface, according to Abney [7]. In the cases with DP above, PRO appears in the position generally occupied by a possessor, but in (26) there is no necessity that the stories belonged to the children or originated with them. There is and can be no morphology showing possession, and therefore Abney would predict that there is no possessor role assigned to the Spec of DP. If this is the case, then the empty category in subject position cannot be PRO unless it is receiving a theta role from another source. If we assume, as does Williams [14], that nouns like pictures are predicatives, then it might be possible to claim that it is stories, not the head D that assigns the theta role to the spec of DP. Whether or not this argument is true, it must still be admitted that some nouns have no theta grid, for example the word orange in (28) or money in (29), making it difficult to explain how an empty category subject can receive a theta role.

28) John loves [dp e [np oranges.]]

And yet, we are tempted to believe that an empty category still exists in this position. Although there is no surface morphology for genitive, there is undoubtedly a control relationship between an implicit argument in Spec DP and the matrix subject when certain nouns are used, as can be seen from (29).

29) When he died, John left [dp e, money] to Mary.

In (29) it is understood that John left his own money to Mary and not someone else’s. If we continue to assume that this implicit argument fills a structural position, then it must receive a theta role from some source in compliance with the theta criterion. Unlike PRO, the empty element in (29) at first sight seems to be able to be replaced by an overt pronoun with no loss of grammaticality, as in (30).

30) John, left [dp his, money] to Mary.

This is a better understood example where the pronoun his receives both case and a theta role from D and displays genitive morphology at S structure. In a sentence like (31i) which unarguably contains PRO, if PRO is replaced with an overt pronoun, ungrammaticality results (31ii).

31i) John, promised Bill [cr [ip PRO, to go]]

i) *John, promised Bill [cr [ip him, to go]]

This discrepancy between PRO and the empty category in DP could be used as an argument against
having PRO in subject position of DP, on the assumption that the empty category in Spec DP and PRO do not behave in the same fashion. However, when INFL becomes tensed, the existence of PRO in Spec IP is no longer possible and an overt subject needs to be used.

32) John{36} promised Bill [PR PRO, to go.]
33) John{36} promised Bill [PR he, would go.]

In this light, the behavior of PRO in (32-33) is mirrored by the empty element in DP in (34-35) and again is expected on the assumption that INFL and D both have similar properties. INFL can only be a governor when tensed and D can only be a governor when case marking Spec DP. In both instances, PRO is not allowed.

34) John{36} promised [PR PRO, help for the needy].
35) John{36} promised [PR his, help to the needy].

If the empty category in Spec DP is indeed PRO, then one adjustment to Abney's theory follows. The head D must assign a theta role other than possessor, but not case, to Spec DP when there is no genitive morphology on the surface. Postulating that D could assign two distinct types of theta roles is a departure from the view that INFL and D show a great deal of similarity, but must be taken in the light that D has already been shown to assign one theta role while INFL assigns none. Clearly more work is needed to define the interaction between D and the empty category subject of the DP.

II. CONCLUSION

It is obvious from the discussion that the standard binding theory (CFC BT) will encounter difficulties when used within the DP framework proposed by Abney [7]. The insertion of the extra node DP causes a c-command problem which can be dealt with adequately by using a mechanism of index percolation derived from Cowper's [8] rules governing feature percolation. The postulation of an empty category subject of DP facilitates the analysis of NP picture reflexives and allows the theory to discard the arbitrary stipulations regarding the forced use of the i-over-i rule and the nonapplication of the licensing conditions. In short, the licensing conditions always apply. While the empty category subject of DP seems to resemble PRO in the IP, establishment of its exact nature remains the purview of future research, as does working out appropriate rules of control.

IV. REFERENCES

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