# On Deriving Constraints on Bound Anaphora[1]

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**Lee, Hyunoo.** 1998. **On Deriving Constraints on Bound Anaphora.** *Language and Information* 2.1, 214-255. Close examination of previous constraints on bound anaphora that are designed to directly constrain the distribution of referentially dependent (RD) items shows that no universal structural relation may exist that relates RD items to their antecedents. As an alternative to these constraints, this paper proposes an axiom of semantic interpretation, called the Principle of Referential Autonomy, which dispenses with any pretheoretical notion of grammatical functions or configurational notion like c-command. Together with certain English-specific facts, this principle enables us to infer the ungrammaticality of core examples of strong and weak crossover. **(Inha University)**

## 1. Introduction

Bound anaphora in natural languages impose some difficult tasks on generative grammarians. Among these tasks are to predict where bound anaphora are possible and to explain the cases where they are not. For these ends, some structural as well as semantic constraints on bound anaphora have been

[1]This research has been partially supported by the 1996 Inha Research Grant.

proposed. In this article, restricting attention to English, I will attempt to develop a general theory of bound anaphora which enables us to partially derive the effects of those constraints from positive evidence available. On the proposed approach, a contrast like the one between the (a) sentences and the (b) sentences in (1)-(3) can be accounted for without appealing to any condition that directly constrains the distribution of pronouns interpreted as variables.

(1) a. Everyone$_i$ loves himself$_i$.
    b. *He$_i$/Himself$_i$ loves Everyone$_i$.
(2) a. Everyone$_i$'s mother loves him$_i$.
    b. *His$_i$ mother loves everyone$_i$.
(3) a. Some daughter of every author$_i$ hated some relatives of his$_i$ wife.
    b. *Some relatives of his$_i$ wife hated some daughter of every author$_i$.

More specifically, it is possible to infer the ungrammaticality of the (b) sentences, which have been said to illustrate the effect of crossover in the literature, from positive data like the (a) sentences and a single axiom of semantic interpretation, called the Principle of Referential Autonomy (PRA).

An informal statement of the PRA which is designed to give the basic idea but which contains many terms to be explicitly defined later, is provided in (4). .

(4) Principle of Referential Autonomy (Informal)
    Natural languages provide a uniform way of structurally identifying at least one NP in basic sentences as referentially autonomous.

NPs like proper names, definite descriptions, and quantified NPs are referentially autonomous (RA), since the contribution of their denotation toward the truth value of the sentences in which they occur is independent from other expressions in the sentences. By contrast, NPs like reflexives, reciprocals, and pronouns construed as bound variables are referentially dependent (RD), since the contribution of their denotation toward the truth value of the sentences in which they occur is dependent upon other expressions in the sentences. Given this informal distinction, the NPs that are structurally identified as RA in (5) by the grammar of English are the ones bracketed.

(5) a. [John] criticized Mary.
b. [Every student] criticized every student.
c. [Every student] criticized himself.
d. [Every student$_i$] criticized his$_i$ teacher.

Note that other NPs in these sentences may in fact be RA, but the PRA for the English grammar does not force that. For example, all occurrences of *every student* in (5b) are RA, but only the subject occurrence must be, as (5c-d) show.

Given our means, spelled out in section 3, of structurally identifying the RA NP in English, we will predict the judgments in (6).

(6) a. *Himself laughed.
b. *Himself$_i$ criticized Bill$_i$.
c. *Himself$_i$ criticized himself$_i$.

The reason is that the NPs structurally identified as RA here in

fact fail to be RA, rather they are referentially dependent. By the same token, the ungrammaticality of the (b) sentences in (1)-(3) will be predicted.

As stated in (4), the PRA constrains the distribution of RA NPs. Then, in principle, RD NPs may occur anywhere consistent with the distribution of the RA ones (though, in practice, there will be some additional constraints). Given that different languages have different means of structurally identifying RA NPs, this allows directly that they, in effect, constrain the distribution of RD NPs and their antecedents in different ways. Thus our approach in principle allows for somewhat different distributions of RD NPs in different languages.[2]

In section 2, I will discuss some of the constraints on bound anaphora that have been proposed to directly constrain the distribution of RD items. It will be shown that no universal structural relation may exist that relates RD items to their antecedents. In section 3, I will formulate the PRA in mathematically rigorous terms that dispense with any pretheoretical notion of grammatical functions or configurational notion like c-command. In section 4, I will show that together with certain English-specific facts, the PRA enables us to infer the ungrammaticality of examples like the (b) sentences in (1)-(3) from their grammatical counterparts. In other words, it provides a unified account of strong crossover (SCO) and weak crossover (WCO). This revision will enable us to deal adequately with certain intractable bound anaphora facts associated with coordination.

## 2. Previous Approaches to Bound Anaphora

[2]For more discussion of this point, see Lee 1993, 1994.

## 2.1. Paradigmatic Cases

Since the earliest period of transformational grammar, it has been observed that there is a restriction on the referential dependency between certain lexical items such as pronouns, reflexives, or reciprocals and nonreferential expressions such as wh-phrases or quantified NPs. The following set of examples illustrates what such a restriction would be:

(7) a. Everyone$_i$ loves himself$_i$.
    b. Nobody$_i$ married the man who she$_i$ hated.
(8) a. *His$_i$ mother claimed that nobody$_i$ won the game.
    b. *His$_i$ friend wondered who$_i$ came to the party.
(9) a. *He$_i$/Himself$_i$ loves everyone$_i$.
    b. *Who$_i$ did he$_i$ say that Mary loved?
(10) a. *His$_i$ mother loves everyone$_i$.
    b. *Who$_i$ did his$_i$ mother say that Mary loved?

In (7a) the reflexive pronoun *himself* is bound to the subject NP *everyone*. In (7b) the subject NP, *she*, of the relative clause is bound to the subject NP of the matrix clause *nobody*. It is uncontroversial to treat pronouns as variables when they are bound by wh-phrases or quantified NPs. Unlike the sentences in (7), the ones in (8)-(10) do not allow an RD item such as *his* or *himself* to be construed as a variable bound by a wh-phrase or quantified NP.

It has often been suggested that the sentences in (8)-(10), which lack the bound variable reading, have quite different properties. There is a clear difference between the sentences in (8) and the ones in (9)-(10). Empirical work shows that in

examples like (8), the scope of a quantified NP or wh-phrase is restricted to the clause in which it occurs. In (8a) the quantified NP *nobody* has scope over the embedded clause, and in (8b) the scope of the wh-phrase *who* is limited to the complement clause due to the subcategorization feature of *wonder*. In both examples the pronoun *his* lies outside of the scope of its intended antecedent. By contrast, in the sentences of (9) and (10), all of the RD items occur within the scope of their intended antecedent, the matrix clause. Nonetheless, no bound variable construal is available in those sentences. As Wasow (1972) notes, there is also a difference between the sentences in (9) and the ones in (10). The former illustrate SCO and the latter, WCO. They are so called by Wasow because the judgment involved in the SCO examples is stronger than the one involved in the WCO examples.

## 2.2. Some Proposed Constraints

Although various accounts have been proposed to explain the paradigm in question, the contrast between (7) and (8) has led virtually all linguists and philosophical logicians to agree that RD items must be in the scope of their quantified antecedents. They, however, disagree as to how to determine and represent scope. On one view, the surface structure of natural languages is assumed to be inadequate to represent scope, and hence scope is syntactically represented at a (disambiguating) level of representation called Logical Form (LF). Chomsky 1976, 1982, May 1977, 1985, Aoun, Hornstein, and Sportiche 1980, Higginbotham and May 1980, and Huang 1982 are representative of this view.

Given the standard definition of scope in (11a), something like (11b) has been proposed as the necessary condition for the bound variable construal of pronouns.[3]

(11) a. The scope of α is the set of nodes that α c-commands at LF.
b. A pronoun P is construed as a variable bound by a quantifier Q raised by May's (1977) Quantifier-Raising (QR) only if P is in the scope of Q.

This LF condition would correctly predict the absence of a bound variable construal in (8), given that independent constraints block the quantificational phrases in (8) from taking scope over the matrix clauses where the pronouns occur.

The necessary condition in (11b), however, cannot explain the fact that no bound variable interpretation of RD items is possible in the crossover examples in (9) and (10). This is so because these RD items would be within the scope of their quantificational antecedents in the LF representations of those examples. The first serious attempt to account for crossover effects in terms of properties of LF is provided by Chomsky 1976, which implicitly assumes (12).

(12) A pronoun (i.e. RD item) may not be directly bound by a quantifier (at LF).

As Lasnik and Stowell (1991) point out, it follows from (12) that

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[3]Otherwise mentioned, the following definition of c-command will be used in this paper:

(i) α c-commands β iff neither of them dominates the other and every branching nodes dominating α also dominates β.

to be interpreted as a variable, a pronoun must be anaphoric to the trace which in turn must be bound at LF by an operator such as a wh-moved NP or a quantified NP raised by QR. Given this, the ungrammaticality of (9) and (10) has been naturally attributed to the violation of a well-formedness condition on the anaphoric relation formed at LF by the RD items and the traces of operators. In this connection, it is worth noting that SCO and WCO give rise to structurally different anaphoric relations at LF: an RD item c-commands the trace of a quantificational NP in the LF representation of (9), but neither of them c-commands the other in the LF representation of (10). This suggests that SCO and WCO must be handled by two different mechanisms on LF-based accounts of bound anaphora.

One standard explanation of SCO based on the structural properties of LF attributes the ungrammaticality of (9) to a violation of Principle C of the binding theory:[4]

(13) Principle C of the Binding Theory (Chomsky 1986b)
An R-expression is free (in the domain of the head of its chain).

(13) means that an R-expression must either be free or have as a local binder an element in an A'-position. On this account, (9a) is mapped to the LF representation in (14).

(14) $[_{IP}$ everyone$_i$ $[_{IP}$ he$_i$/himself$_i$ loves $t_i]]$

Given that wh-traces and traces left behind by QR are R-expressions, the trace $t_i$ must be A(rgument)-free in (14).

[4]A treatment of SCO along this line originates in Chomsky 1976.

However, $t_i$ is bound by the subject NP *he/himself*, violating Principle C. Likewise, the bound variable construal of the pronoun *he* is excluded in (9b), since the wh-trace is A-bound by the matrix subject NP *he* at LF.

By contrast, WCO examples like (10) cannot be ruled out by Principle C since it fails to block an RD item from being anaphoric to the trace bound at LF by a wh-moved NP or a quantified NP raised by QR. Let us consider (15a) and (15b), which are the LF representations of (10a) and (10b), respectively.

(15) a. [$_{IP}$ everyone$_i$ [$_{IP}$ his$_i$ mother loves $t_i$]]
b. [$_{CP}$ who$_i$ did [$_{IP}$ his$_i$ mother say [$_{CP}$ that Mary loved $t_i$]]]

In both (15a) and (15b), the pronoun *his* and the trace $t_i$ fail to c-command each other. Hence Principle C cannot be applied. Nonetheless, no bound variable interpretation of *his* is available in (10a) and (10b). To cope with this problem, Chomsky (1976) proposes the Leftness Condition in (16).

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

The Leftness Condition then blocks the pronoun *his* from being anaphoric to the trace to its right in the LF representations in (15).

Reinhart (1983a) and Haïk (1984) argue that c-command but not precedence is relevant to the bound anaphora problem. Reinhart (1983a) provides the following sets of examples as evidence for her claim:[5]

[5]Reinhart (1983a) discusses many other examples of different types. Some of

(17) a. *People from [each of the small western cities]$_i$ hate it$_i$.
b. *Gossip about [every businessman]$_i$ harmed his$_i$ career.
c. *The neighbours of [each of the pianists]$_i$ hate him$_i$.

(18) a. *In everyone's$_i$ office, he$_i$ is an absolute dictator.
b. *According to every candidate$_i$, he$_i$ is a real democrat.

In the LF representations of the above examples, the traces of the quantified NPs are coindexed with the pronouns to their right, satisfying (16). However, they are all ungrammatical according to Reinhart. Safir (1984) discusses further examples in favor of a c-command-based analysis of WCO:

(19) a. *Who$_i$ did you give [a picture of t$_i$] to him$_i$?
b. *Who$_i$ did you convince [friends of t$_i$] to talk to him$_i$?

The examples in (19) are also problematic for the Leftness Condition (16) since it would incorrectly predict the availability of a bound variable construal in them.

Based on examples like the ones considered, it has been proposed that the following is a true descriptive generalization for WCO:

(20) In a configuration where a pronoun P and a trace T are both A'-bound by a category C, T must c-command P.

Consider (15) again, repeated as (21).

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them are as controversial as (17). May (1985) claims that all the examples in (17) admit of bound variable anaphora easily. For more discussion, see also Lasnik and Stowell 1991 and Stowell, to appear.

(21) a. [$_{IP}$ everyone$_i$ [$_{IP}$ his$_i$ mother loves $t_i$]]
b. [$_{CP}$ who$_i$ did [$_{IP}$ his$_i$ mother say [$_{CP}$ that Mary loved $t_i$]]]

In (21a) the trace $t_i$ of *everyone* fails to c-command the pronoun. In (21b) the wh-trace $t_i$ also fails to c-command the pronoun *his*. Both representations thus violate (20). Hence, sentences (10a) and (10b) do not allow for the bound variable construal of *his*.

Considerable efforts to derive (20) from the primitives of grammar have been made within the GB framework. Koopman and Sportiche (1983) propose that the effect of (20) is due to the so-called Bijection Principle in (22).

(22) Bijection Principle
Each operator must A'-bind exactly one variable, and each variable must be A'-bound by exactly one operator.

Koopman and Sportiche assume Chomskys (1981) definition of a variable in (23).

(23) α is a variable iff α is locally A'-bound and in an A-position.

By virtue of (23), the pronoun *his* and the trace $t_i$ in (21a) count as variables bound by the operator *everyone*. Since the binding relation shown in (21a) is not one-to-one, (21a) is ruled out by the Bijection Principle. Similarly, in (21b) the wh-operator A'-binds both the pronoun inside the subject NP and its trace $t_i$. Since this violates the Bijection Principle, the sentence with the bound variable construal of *his* is predicted to

be ungrammatical.[6]

As implied in the beginning of this section, there is an alternative view of scope. On this view, scope is determined solely by the properties of surface structure. Reinhart (1983a, b) and Haïk (1984) argue that quantified NPs can have scope over the elements in their c-command domain at the surface structure enriched with wh-traces, even though the latter allows NPs occurring in the same minimal sentence to freely take scope over each other. Bach and Partee (1980) and Partee and Bach (1981) treat wide scope quantification in terms of Cooper's (1975) Storage mechanism, which makes LF unnecessary. Keenan (1988b, 1989) also shows that surface structure is sufficient to represent scope ambiguity in the minimal transitive sentences by extending the NP denotations. All of these theories, however, would preclude the quantificational phrases in (8) from taking scope over the matrix clauses where the pronouns occur and thus rule out the bound variable construal of the pronouns.

It is worthy of note that whether scope is defined as a property of LF or surface structure, the surface position of a quantificational phrase is not an absolute factor; all the theories would allow the quantificational phrases in (9) and (10) to have

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[6]Safir (1984) proposes an alternative way of deriving (20). He formulates the Parallelism Constraint on Operator Binding (PCOP) as in (i).

(i) If O is an operator and x is a variable bound by O, then for any y, y a variable bound by O, x and y are [alexical].

Though the PCOP and the Bijection Principle make empirically different predictions regarding Parasitic Gap Constructions and the Across-the-Board Constructions, it is controversial whether these constructions are real counterexamples to the Bijection Principle, as pointed out by Lasnik and Stowell (1991).

scope over their matrix sentences. This means that to explain the unavailability of bound anaphora in those sentences, some qualification must be placed upon the initial condition that RD items must be in the scope of their antecedent, or a further constraint must be added.

Reinhart (1983a, b) proposes that the necessary condition be qualified as follows:

(24) Quantified NPs and wh-traces can have anaphoric relations only with pronouns in their c-command syntactic domain at S-Structure.

Condition (24) then accounts for both the SCO examples in (9) and the WCO ones in (10). Given the structure of these examples that empirical work supports, the RD items would not be c-commanded at S-Structure by the quantified NP or the wh-trace. In addition, (24) would account for both the grammmatical sentences in (7) and the ungrammatical ones in (8), regardless of the clause-boundness of scope.

## 2.3. Some Problematics Cases of Bound Anaphora

I have so far discussed how the paradigm in (7)-(10) is dealt with on LF-based approaches and Reinhart-style surface-based ones. In this section, I will point out that neither of the approaches discussed gives a satisfactory account of the distribution of RD items in English.

I will first show that not all cases of bound anaphora can be determined at LF. This is borne out by the following example:

(25) a. John interviewed every student$_i$ or his$_i$ mother.
b. For every student x, John interviewed x or x's mother.

As the translation in (25b) shows, the pronoun *his* is construed as a variable bound by *every student*. For discussion of the bound variable anaphora within coordinate NP structures, see Keenan and Faltz 1985 and Tyhurst 1990. Clearly, it is not an E-type pronoun in the sense of Evans 1980, since the sentence does not mean that John interviewed every student or the mother of the student that John interviewed. The availability of the bound variable construal of *his* in (25a) poses a problem for the approaches that treat bound variable anaphora as LF phenomena. By virtue of Ross's (1967) Coordinate Structure Condition (CSC), no LF representation can be derived in which *every student* is extracted to an A'-position from the coordinate NP structure. Despite the absence of such an LF representation, we get the bound variable construal of the pronoun in (25a). This fact suggests that the availability of bound variable anaphora may not be a property of LF, but determined in some other component of grammar.

The above fact shows that the LF approaches fail to predict *where a pronoun is interpreted as a bound variable in simple sentences*. Reinhart's (1983a, b) condition in (24), however, correctly accounts for the availability of the bound variable construal of a pronoun in sentences like (25a). Whether coordinate NPs have a symmetric or asymmetric constituent structure, the first conjunct NP c-commands any element contained in other conjunct NP, in the sense of Reinhart 1976. Hence (25a) conforms to (24).

The second problem for the LF-based analyses is provided by

the examples where a quantified NP embedded in a boolean compound gives rise to the same crossover effect. Consider the examples in (26).

(26) a. *$His_i$ supporters admired every $senator_i$ and Ross.
b. For every senator x, x's supporters admired x and Ross.
(27) a. Someone hated every senator and Ross.
b. There is someone x such that for every senator y, x hated y and Ross.
c. For every senator y, there is someone x such that x hated y and Ross.

In (26a) the bound variable construal of *his* is blocked. It is not clear at all how this could be accounted for on the LF-based approaches. No plausible LF representation of (26a) to which the Bijection Principle in (22) applies can be derived due to the CSC. Hence the LF approaches fail to predict *where a pronoun is not interpreted as a bound variable.* The ungrammaticality of (26a) cannot be simply attributed to what is responsible for the ungrammaticality of (8) since the quantified NP *every senator* may indirectly take scope over the matrix clause, as shown by the ambiguity of (27a). This suggests that (26a) is also an example of WCO. It also suggests that representing scope at LF via QR is not sufficient whenever a quantified NP forms a boolean compound, as in (27a). See Tyhurst 1990 for a possible solution to this problem. Note that condition (24) correctly predicts the unavailability of the bound variable construal in (26a), since the pronoun is not c-commanded by the quantified NP *every senator* at S-Structure.

We have seen that the LF-based accounts fail to predict

where bound anaphora is possible or impossible. In what follows, I will show that even the surface-based accounts encounter some empirical difficulties.

First of all, as Reinhart (1983a, b) herself points out, the condition in (24) is not general enough to handle what we can plausibly call examples of crossover. This is because (24) is formulated in such a way that the antecedents of bound pronouns are restricted to quantified NPs and wh-phrases via wh-traces. In order to overcome the difficulty, one may restate (24) along the following line:

(28) To be construed as variables, pronouns must be in the c-command domain of definite NPs, quantified NPs, and wh-traces at surface structure.

The revision in (28) is motivated by the fact that a pronoun may be construed as a variable even when it is c-commanded by a definite NP, as in (29).

(29) a. John loves his mother, and so does Mary.
b. John$_i$ loves his$_i$ mother and Mary$_j$ loves his$_i$ mother.
c. John$_i$ loves his$_i$ mother and Mary$_j$ loves her$_j$ mother.

As Reinhart (1983a, b) observes, a sentence like (29a) is ambiguous between the strict identity reading in (29b) and the sloppy identity reading in (29c). The availability of the latter reading shows that the pronoun *his* is interpreted as a bound variable even when it is anteceded by a definite NP in a sentence like the first conjunct of (29a).

Although (28) deals adequately with RDs whose antecedents

are definite NPs, it is not problem-free. As pointed out by researchers like Higginbotham (1980a), May (1985), Reinhart (1987), and Stowell (to appear), some examples of bound anaphora show that (28) is too strong. Among them are the following:

(30) a. Every man$_i$'s mother supports him$_i$.
b. Nobody$_i$'s mother criticized him$_i$.
(31) a. Someone from every city$_i$ despises it$_i$.
b. Some daughter of every author$_i$ hated some relatives of his$_i$ wife.

(30) illustrates possessive bound anaphora, and (31), inverse-linking anaphora. Higginbotham (1980a), May (1985), and Reinhart (1987) argue that in sentences like (30), anaphora is possible for many speakers although quantified possessive NPs fail to c-command pronouns at surface structure. Bach and Partee (1980), on the other hand, hold that the pronouns in (30) are not genuine bound variables, but examples of Cooper 1979's pronouns of laziness. According to their analysis, (30a) means that every man's mother supports her son. As Cooper (1983) points out, however, this interpretation requires that mothers who have exactly one son love their sons while (30a) seems to mean something stronger. This strongly suggests that the pronouns in (30) are true cases of bound anaphora. As for inverse-linking anaphora, it seems that judgments vary among people. Higginbotham (1980a), May (1985), and Stowell (to appear) treat sentences like (31) as bound anaphora examples. Reinhart (1983a) and Williams (1986) basically do not accept inverse-linking anaphora, but they judge some inverse-linking

examples like (31a) and (32) acceptable.

(32) Every daughter of every professor in [some small college town]$_i$ wishes she could leave it$_i$.

Despite the absence of general agreement as to inverse-linking bound anaphora. I will just assume that they are cases of true bound variables. The above discussion shows that (28) is too strong to explain where pronouns may be construed as variables in English.

## 3. The Principle of Referential Autonomy

In the previous section I argued that some aspects of English bound anaphora cannot be handled by any of the putative universal constraints on bound anaphora. The point that they are either too constrained or too general might have its own merit, but it is not itself of great importance to our understanding of bound anaphora in general. It seems to me that a genuine universal property of bound anaphora consists in the paradigmatic relation between grammatical examples of bound anaphora and corresponding ungrammatical ones, rather than in the intrasentential relation between RD items and their antecedents. As we shall see, the Principle of Referential Autonomy that I will formulate here codifies some linguistically significant paradigmatic generalizations which are crucial to our explanation of crossover examples.

Let us begin with the following informal version of the principle:[7]

[7]Before we proceed, I should note that the PRA in (33) has an informal

(33) Principle of Referential Autonomy (Informal)
For each language L,
i. in each nuclear sentence S of L, at least one independent NP occurrence is referentially autonomous, and
ii. L provides a structurally uniform way of identifying the required RA NP in each S. That is, whenever sentences S and T are isomorphic (= have the same structure) then the NP L identifies in T is the isomorphic image of the one it identifies in S. I.e., it makes the same choice for T as it does for S.

Before giving a somewhat more rigorous statement of the PRA, I should elaborate on some of the basic notions used above. Suppose XP is an arbitrary phrase. An XP occurrence is called INDEPENDENT iff it is not a proper subconstituent of another XP occurrence. For example, only *John* and *Bill's mother* are independent NP occurrences in *John criticized Bill's mother*. A sentence S is an N-ARY NUCLEAR sentence iff (i) S consists of *n* independent NP occurrences, an *n*-ary predicate, and nothing else, and (ii) S is independent. *John laughed* is a unary nuclear sentence, and *John criticized Bill*, a binary nuclear one. But neither *John thinks that Bill laughed* nor *John came early and Bill came late* is a nuclear sentence. By definition, the string *Mary laughed* cannot count as a nuclear sentence if it is embedded in a string like *John said Mary*

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precursor in Keenan 1976.

(i) Principle of Autonomous Reference
In the basic sentence types of a language L, a combination of case-marking, position, and verb agreements function to identify exactly one NP as being in principle autonomous in reference.

*laughed.*

Let us now consider (34) and (35).

(34) a. [Most of John's students] criticized [Bill].
b. [No student in LA] reads [every paper published in the USA].

(35) a. No student criticized [himself].
b. Each student$_i$ criticized [his$_i$ teacher].
c. John criticized [everyone but himself].

All the bracketed NPs in (34) are referentially autonomous. They do not depend on expressions outside of them for their contribution towards the truth conditional meaning of the sentences they occur in. Their contribution is determined solely by the interpretations of their parts. By contrast, all the bracketed NPs in (35) are referentially dependent. Unlike the RA NPs given in (34), they depend on expressions outside of them for their contribution towards the truth conditional meaning of the sentences they occur in.

Keenan (1988, 1989) mathematically characterizes the difference between RA NPs and RD ones for the contexts of interest to us. Here I just illustrate the essential idea. Let X be an NP. To say that X in (36a) below is not referentially dependent on *John* is to say that the truth of (36a) does not depend on who John is; it just depends on what objects John criticized.

(36) a. John [criticized X].
b. Bill [criticized X].

So if Bill criticized exactly the same objects that John did, then

(36a) and (36b) must have the same truth value (both true or both false) if X is RA. Consider (37).

(37) a. John criticized most of Sam's students.
b. Bill criticized most of Sam's students.

Suppose Bill criticized exactly the same objects that John did, say, John, Bill, Karin, and, Mary. Suppose further everyone but Mary is Sam's student. Then, both (37a) and (37b) are true. Suppose no one but Mary is Sam's student. Then, both (37a) and (37b) are false. By contrast, *himself* is not referentially autonomous. It may be that John and Bill criticized exactly the same objects but that (36a) is false but that (36b) is true. Consider (38).

(38) a. John criticized himself.
b. Bill criticized himself.

Suppose that John criticized Bill, Karin, and Mary and that those are just the objects Bill criticized. Then, (38a) is false but (38b) is true. Thus, *himself* in (38a) is referentially dependent on *John*, since we may change truth value if we replace *John* by another name, even though its denotation criticized the same objects John did.

Thus far I have discussed how RA NPs are different from RD ones. Given the distinction between the two types of NPs, we are now able to substantiate the PRA given informally in (33). Let us now consider the paradigm shown in (39)-(41).

(39) *John* laughed. **one** RA NP

(40) a. *John* criticized *Bill.* two RA NPs
b. *John* criticized himself. **one** RA NP

(41) a. *John* introduced *Mary* to *Bill.* three RA NPs
b. *John* introduced *Mary* to himself. two RA NPs
c. *John* introduced *Mary* to herself. two RA NPs
d. *John* introduced himself to *Mary.* two RA NPs
e. *John* introduced himself to himself. **one** RA NP

In a unary nuclear sentence like (39), there is only one independent NP occurrence, which is referentially autonomous. A binary nuclear sentence may present two independent RA NP occurrences, as in (40a), or just one, as in (40b). A ternary nuclear sentence may present three independent RA NP occurrences, as in (41a), or just two, as in (41b)-(41d), or just one, as in (41e). These data are consistent with the PRA. But consider (42).

(42) a. *Himself cried.
b. *Himself criticized himself.

Given how *himself* is interpreted in Standard American English, these expressions lack an RA NP and thus are ungrammatical as sentences since they violate the PRA.

Furthermore, the sentences in (39)-(41) bear out the second part of the PRA, which says that all languages provide a uniform way of structurally identifying an NP in nuclear sentences as referentially autonomous. See the italicized *John* in (39)-(41). It seems to be the case that in English nuclear sentences, there is always an NP (provably unique) which is higher in the syntactic analysis tree than the other NPs in the

sentence. This NP, called the subject, is always interpreted as RA in nuclear sentences. We, however, do not require that the identifying mechanisms be given in terms of syntactic hierarchy. The idea underlying UNIFORM IDENTIFIABILITY is that the structure of sentence depends on the lexical items occurring in it and the way they are combined. But our approach allows that different languages combine lexical items in different ways.

To implement our claim, I first introduce the notion of isomorphism invariance drawn from Keenan and Stabler (1992). Following them, we think of a language L as a set of categorized expressions built from a lexicon LEX and a set F of generating functions. Specifically, L is the closure of LEX with respect to the functions f in F. Then, two expressions, s and t, are (syntactically) isomorphic iff each can be mapped to the other by a structure preserving map (a hom). A map (function) h from the expressions of L to the expressions of L preserves structure iff h preserves the domains of the generating functions and h commutes with each of them. That is, whenever f(s) = t then f(h(s)) = h(t) [equivalently: f(h(s)) = h(f(s))]. Then, to say that a function f is isomorphism invariant is just to say that f treats isomorphic expressions in the same way. That is, (43).

(43) Whenever some s is isomorphic to t, then the value f(t) of f at t is the isomorphic image of f(s). Formally, f is isomorphism invariant iff whenever <s, t> ∈ f and <s, t> is isomorphic to <s', t'> then <s', t'> ∈ f.

And we say that an isomorphism invariant function (structurally) identifies its value, since what value f has at a given expression is determined by the structure of that expression—once the

structure of S in Dom(f) is given then the value of f at S is determined.

Given the above notions, it is now possible to state the PRA more formally as in (44).

(44) Principle of Referential Autonomy (Formal)
For each natural language L, there is an isomorphism invariant function $f_L$ such that (i) and (ii):
i. $Dom(f_L)$ includes all nuclear sentences of L, and
ii. For each nuclear sentence S, $f_L(S)$ is an independent RA NP occurring in S.

The domain of the function whose existence is guaranteed by the PRA includes all *n*-ary nuclear sentences. The PRA says that at least one of the independent NPs is structurally identifiable and RA in every nuclear sentence. Where the language is English, we are tempted to call the function referred to in the PRA $Subject_L$ or $Nom_L$, but this notation is misleading. It is in fact implausible to think that any pretheoretical notion of subject or nominative applies uniformly to languages with different structures. E.g., in Batak, the RA NP identified as a function of the structure of Batak sentences does not correspond to the NP we might pretheoretically call subject in English; it is sometimes the agent, and sometimes not. Cf. Keenan (1988, 1989). For this reason, I will call the function referred to in (44) $RAF_L$ (for the referential autonomy function in L).

## 4. Deriving Crossover Effects from the PRA

In section 2 I argued that the relation between RD items and

their antecedents in English is not structurally definable and hence the effects of crossover must be ascribed to a principle which is motivated independently from bound anaphora. In the light of this, in section 3 I formulated the Principle of Referential Autonomy that requires at least one of the RA NPs in a nuclear sentence to be structurally identified. In the present section, I will show how to explain the ungrammaticality of some core examples of crossover in terms of the PRA.

Before doing this, we first observe that for each of the ungrammatical strings in (1)-(3), repeated as (45)-(47), there is a corresponding grammatical sentence.

(45) a. Everyone$_i$ loves himself$_i$.
b. *He$_i$/Himself$_i$ loves everyone$_i$.
(46) a. Everyone$_i$'s mother loves him$_i$.
b. *His$_i$ mother loves everyone$_i$.
(47) a. Some daughter of every author$_i$ hated some relatives of his$_i$ wife.
b. *Some relatives of his$_i$ wife hated some daughter of every author$_i$.

That is, if the (b) sentences were grammatical, they would have the same structure as their grammatical counterpart, which is a natural assumption agreed upon by all grammatical theories.

## 4.1. Strong Crossover

I will now show how the PRA plus some English-specific facts allow us to explain the SCO effect illustrated by (45).

Note first that empirical study of English supports the claim

that sentences (48a) and (48b) are isomorphic:

(48) a. Everyone loves Bill.
b. Someone criticizes Frank.

In particular, there are a structure preserving map *h* which maps *everyone* to *someone*, *loves* to *criticizes*, and *Bill* to *Frank* and a structure preserving map *k* which maps *someone* to *everyone*, *criticizes* to *loves*, and *Frank* to *Bill*. Moreover, *h* maps *loves Bill* to *criticizes Frank*, and *k* maps *criticizes Frank* to *loves Bill*. Whether the two sentences are isomorphic is determined by how they are built up—so I am making assumptions regarding the grammar of English here. These are empirical claims—not justified here but just taken for granted. They are unproblematic on all theories. Note also that a function *h* mapping (48a) to (48b) cannot preserve structure if *h* maps, say, *everyone* to *Frank*. A structure preserving map which sends *everyone* to *Frank*, *loves* to *criticizes*, and *Bill* to *someone* will map (48a) to *Frank criticizes someone*, not to (48b).

Now consider the sentences in (49).

(49) a. Everyone loves himself.
b. Someone criticizes himself.

Again, it is obvious that (49a) and (49b) are isomorphic. There are a structure preserving map *h* mapping *everyone* to *someone*, *loves* to *criticizes*, *himself* to *himself*, and *loves himself* to *criticizes himself* and a structure preserving map *k* mapping *someone* to *everyone*, *criticizes* to *loves*, *himself* to *himself*, and *criticizes himself* to *loves himself*. Furthermore, as I justified in

(38), *himself* is referentially dependent. More specifically, *himself* is interpreted as the SELF function in (50a), and thus (49a) is assigned the reading in (50b).

(50) a. SELF(R) = {b: bRb}, for any binary relation R
b. **EVERYONE**(SELF(LOVE))
= **EVERYONE**(λx[x LOVE x])

Note that interpreting *himself* as the SELF function is a language-particular fact regarding *himself*. It does not hold, for example, in Irish English, as Keenan (1988, 1989) shows. Indeed, (42a) and (42b) must be accounted grammatical in that language.

We can now infer the ungrammaticality of (51) from (52):

(51) *Himself$_i$ loves everyone$_i$.

(52) a. empirically given positive data such as (49)
b. isomorphism assumptions illustrated by (48) and (49)
c. empirically determined interpretation of *himself* in (50a)
d. PRA

Argument: Suppose, contrary to fact, that (51) is grammatical. Then the referential autonomy function for English, $RAF_{English}$, which must identify *everyone* as an RA NP in (49a), must identify *himself* as an RA NP in (51), since $RAF_{English}$ is isomorphism invariant and since the isomorphism assumptions in (52b) guarantee that (49a) and (51) are isomorphic. By (52c), however, this leads to a contradiction. Thus, $RAF_{English}$ no longer structurally identifies an NP in this nuclear sentence as RA, violating the PRA. Since the PRA is inviolable, we must abandon our initial assumption that (51) is grammatical. A

sentence like (51) can be never generated by language learners once they learn the anaphoric dependencies displayed by sentences like (49).

I have shown that the positive data in (49), working jointly with (52b) and (52c), all based on positive data, determine the negative judgement in (51). What remains is to account for the ungrammaticality of (53).

(53) *$He_i$ loves $everyone_i$.

Following the traditional wisdom, pronouns may refer or function as bound variables. I assume here that bound variable pronouns but not deictic pronouns are RD. Since crossover is a restriction on binding, we are concerned with only the former type of pronouns. Suppose then that (53) is grammatical. Then, $RAF_{English}$, which must identify *everyone* as an RA NP in (49a), must identify *he* as an RA NP in this sentence. But *he* is not RA, as we assumed, leading to a contradiction. Since $RAF_{English}$ fails to identify an NP as RA in (53), it violates the PRA. In order for the PRA to be satisfied, the pronoun must be interpreted deictically.

## 4.2. Weak Crossover

As we shall see, our account of SCO, based on the PRA and positive data, also enables us to handle the WCO effect without any further stipulation.

Let us begin with (54), which illustrates the simplest case of WCO.

(54) a. Everyone$_i$'s mother loves him$_i$.
b. *His$_i$ mother loves everyone$_i$.

(54b) contains the NP *his mother*. Regardless of whether they are used as subject or object, NPs of the form *his* Noun must be treated as referentially dependent when the pronoun *his* is construed as a variable. Consider (55).

(55) a. Everyone$_i$ criticized [his$_i$ mother].
b. Someone$_i$ criticized [his$_i$ mother].

To say that the NP *his mother* in (55a) is referentially dependent on *everyone* is to say that the truth of (55a) depends on both what objects everyone criticized and what property it has. Suppose everyone criticized exactly the same objects that someone did. Then it may be that (55a) is false but that (55b) is true. This happens in a situation like (56).

(56) There are only three male individuals, John, Bill, and Sam, in the model. They have different mothers. They all criticized Mary, who happens to be John's mother. They, however, criticized no one else.

I have shown that NPs like *his mother* may be RD when they are used as object. It is logically possible to treat them as RD when they are used subject, even though languages like English do not grant this logical possibility, as shown by (54b). As illustration, let us consider (57).

(57) a. [His$_i$ mother] loves John$_i$.

b. [His$_i$ mother] loves Bill$_i$.

To say that the NP *his mother* in (57a) is referentially dependent on *John* is to say that the truth of (57a) depends on both who John is and what objects are such that their mother loves John. Suppose the objects whose mother loves John are the same as the objects whose mother loves Bill. This does not guarantee that (57a) and (57b) have the same truth value. Let Mary be John's mother and let Sue be Bill's mother. If Sue is the only person that loves John, and she is also the only person that loves Bill, (57a) is false, but (57b) is true.

We can now infer the ungrammaticality of (54b) from certain empirically observed language-specific facts. Suppose, contrary to fact, that (54b) is grammatical. Independent conditions will ensure that it is isomorphic to (54a), a grammatical sentence given empirically. Then, RAF$_{\text{English}}$, which must identify *everyone's mother* as an RA NP in (54a), must identify *his mother* as an RA NP in (54b). But *his mother* is not RA when the pronoun is interpreted as a bound variable, as we showed above. This leads to a contradiction. Since the PRA is not violable, the assumption that (54b) is grammatical must be abandoned. To satisfy the PRA, the pronoun in (54b) must be interpreted deictically.

I have so far shown how to derive the lack of bound anaphora in (54b) from the PRA plus certain language-particular facts. Examples of inverse-linking anaphora such as (47), repeated below, are given the same explanation.

(58) a. Some daughter of every author$_i$ hated some relatives of his$_i$ wife.

b. *Some relatives of $his_i$ wife hated some daughter of every $author_i$.

In order to explain the contrast between (58a) and (58b), however, we need to first show that NPs like *some relatives of his wife* are referentially dependent when *his* is construed as a variable. Let us consider (59).

(59) a. Some daughter of every $author_i$ hated some relatives of $his_i$ wife.
b. Some daughter of every $professor_i$ hated some relatives of $his_i$ wife.

Suppose some daughter of every author hated exactly the same objects that some daughter of every professor did. Then it may be that (59a) is false but that (59b) is true. This is borne out by the following situation:

(60) There are only two authors, John and Bill, in the model. John has exactly one daughter named Susie, and Bill, exactly one daughter named Barbara. Susie hated Peter, one of her mother's relatives, and Barbara hated none of her mother's relatives. There is only one professor, Bob, in the model. Bob has exactly one daughter named Jill. Jill hated Peter, who happens to be also one of her mother's relatives.

We can now infer the ungrammaticality of (58b) from (58a), which is given empirically. Suppose, contrary to fact, that (58b) is grammatical. Then, $RAF_{English}$, which must identify *some*

*daughter of every author* in (58a) as RA, must identify *some relatives of his wife* in (58b) as RA, since $RAF_{English}$ is isomorphism invariant and since (58a) and (58b) must be isomorphic. But the expression *some relatives of his wife* is not RA when the pronoun is construed as a variable. Since this leads to a contradiction, (58b) would violate the PRA. Since the PRA is not violable, our assumption that (58b) is grammatical on the bound reading should be abandoned.

I have so far advanced a unified account of SCO and WCO in terms of the PRA plus certain language-particular facts. In the remainder of this section, I will demonstrate that our account of the crossover examples in (45)-(47) suffers from none of the empirical problems associated with the Bijection Principle (22) and the Reinhart-style condition on bound anaphora (28).

Recall that unlike the former condition, the latter one cannot deal adequately with crossover examples that involve possessive anaphora or inverse-linking anaphora. I have already shown that the crossover examples of possessive anaphora in (47) and those of inverse-linking anaphora in (48) fall automatically out of the PRA and given facts.

The surface condition (28) gives a better account than the Bijection Principle (22) when crossover involves definite NP antecedents or coordination. Since the PRA constrains the presence of possible antecedents of RD items, rather than the distribution of RD NPs themselves, it makes the same prediction irrespective of what kind of NP serves to be an antecedent of an RD item. That is, the ways we explain the ungrammaticality of (61a) and (61b) are basically the same.

(61) a. *$His_i$ mother criticized $John_i$.

b. *His$_i$ mother criticized everyone$_i$.
c. Everyone$_i$'s mother criticized John$_i$.

Both are based on empirically given data like (61c) and the PRA.

The real advantage of the PRA-based account of crossover obtains when we take account of the asymmetry of pronominal binding within coordinate structures, which poses a problem for all the LF-based analyses.

A slight modification of the PRA is needed, however, since its application is restricted within (binary) nuclear sentences. To this end, I first generalize the notion *referentially autonomous* to other categories.

(62) An expression is RA iff the computation of its interpretation is *complete* (that is, based solely on the interpretations of its parts and the way they are formed.)

This generalization enables us to treat nuclear sentences as a specific type of RA expressions in that the computation of their interpretation is complete.

Given (62), we can now reformulate the PRA as follows:

(63) Generalized Principle of Referential Autonomy (GPRA)
For each natural language L, there is an isomorphism invariant function $f_L$ such that
i. Dom($f_L$) includes the RA expressions R of L, and
ii. For each RA expression R in Dom($f_L$), $f_L$(R) is an independent RA expression occurring in R.

The domain of the function referred to in (63) includes not only *n*-ary nuclear sentences but also any RA expressions of any category.*

As an example of the asymmetry of pronominal binding within coordinate structures, consider the contrast between (64a) and (64b).

(64) a. Mary interviewed [$_{NP}$ every student$_i$ or his$_i$ mother].
For every student x, Mary interviewed x or x's mother.
b. *Mary interviewed [$_{NP}$ his$_i$ mother or every student$_i$].
For every student x, Mary interviewed x's mother or x.

Observe first that a coordinate NP like *every student or his mother* may be referentially autonomous. This is borne out by the following sentences:

(65) a. Mary criticized [$_{NP}$ every student$_i$ or his$_i$ mother].
b. Sue praised [$_{NP}$ every student$_i$ or his$_i$ mother].

Suppose there are only two students in the model, John and Bill. John's mother is Peggy, and Bill's mother, Martha. Suppose further that Mary criticized exactly the same individuals that Sue praised. Then, on the bound variable reading indicated by coindexation, (65a) is true iff (65b) is. The contrast between (64a) and (64b) then suggests that if a coordinate NP is referentially autonomous, its first conjunct NP must be also referentially autonomous.

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*Note that *n*-ary nuclear sentences are defined here as independent occurrences of referentially autonomous expressions: if they contain no RD NP, they are trivially RA, and if they contain an RD NP anteceded by an RA NP in them, they also count as RA.

As a further example, consider the contrast in (66).

(66) a. Lucie [$_{VP}$ criticized every teacher$_i$ and insulted his$_i$ wife].
b. *Lucie [$_{VP}$ criticized his$_i$ wife and insulted every teacher$_i$].

It is clear from the above discussion that an expression is referentially dependent if it contains an RD NP but not its antecedent, and is referentially autonomous otherwise. In (66a), we can say that the whole VP *criticized every teacher and insulted his wife* and the first conjunct VP *criticized every teacher* as RA, but the second conjunct VP *insulted his wife* as RD. The contrast in (66) leads to a descriptive generalization that a coordinate VP is RA only if its first conjunct VP is RA.

Given the above two facts concerning coordinate conjunction, the referential autonomy function for English is defined as (67).

(67) For any nuclear sentence S, $RAF_{English}(S)$ = the external NP of S. For any RA boolean compound W conjoined by *and*, *or*, or *but*, $RAF_{English}(W)$ = the first conjunct.

We can now account for the absence of bound anaphora in (64b) and (66b). Suppose (64b) is grammatical. Then, $RAF_{English}$, which must identify *every student* occurring in the coordinate NP of (64a) as RA, must identify *his mother* occurring in the coordinate NP of (64b) as RA since $RAF_{English}$ is isomorphism invariant and since the two NPs must be isomorphic. But *his mother* is not RA, hence $RAF_{English}$ fails to identify an RA expression in the coordinate NP of (64b), which must be also RA. This would then violate the GPRA (63), hence no bound anaphora is admitted. A similar account is given to (66b).

## 5. Concluding Remarks

In the previous sections, I characterized crossover as a manifestation of the anaphor-antecedent asymmetry and proposed a unified analysis of SCO and WCO in terms of the PRA plus empirically given language-specific facts. I showed that the PRA-based approach to crossover provides a better account than LF-based or surface-based conditions that directly constrain the relations between RD items and their antecedents.

In closing this paper, I would like to make a final note that our unified account cannot explain the well-known fact that the judgment involving SCO is worse than the judgment involving WCO. I simply suggest that this difference may be attributed to the different perceptual status of RD items and syntactically complex RD NPs. RD items such as *himself* or *he/him* are purely nonreferential since they are construed as variables. Syntactically complex RD NPs such as *his mother*, *both himself and Mary*, and *some relatives of his wife* are not purely nonreferential in that their denotations are composed of variables and something else. It appears that the structural complexity involved in such RD NPs weakens the effect of the anaphor-antecedent asymmetry. For the suggestion regarding the perceptual difference between SCO and WCO, I am indebted to Stowell, to appear.

On the basis of the following descriptive generalization for WCO:

(68) In an LF configuration where a category C A'-binds a pronoun P and a trace T, P may not be contained in an argument phrase XP that c-commands T.

Stowell (to appear) proposes to reduce WCO to a special case of SCO. Elaborating on the slash-indexing mechanism introduced by Haïk (1984) and Safir (1985), he revises Principle C so that it blocks a trace with the [-pronominal] index from being c-commanded by the argument NP whose inherent or slashed index with [+pronominal] is the same as the index of the trace. Under the theory of slash-indexing, (46b) will be assigned the following LF representation:

(69) $[_{IP}$ everyone$_i$ $[_{IP}[_{NP}$ his$_i$ mother$]_{j/i[+pronominal]}$ loves $t_i]]$

In (69) *his mother*$_{j/i[+pronominal]}$ c-commands $t_i$, violating Principle C. This analysis gives a correct result in the cases of (45)-(47). However, it has difficulty explaining the lack of bound anaphora in the (b) sentences of (70) and (71), since no appropriate LF representations to which Principle C applies are generable for the reasons mentioned before.

(70) a. Every senator$_i$ admired his$_i$ mother and Ross.
b. *His$_i$ supporters admired every senator$_i$ and Ross.

(71) a. Everyone$_i$'s mother loved him$_i$.
b. *His$_i$ mother loved John$_i$. (* on the bound reading)

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received: April 25, 1998.
accepted: June 29, 1998.