Yosef Grodzinsky
Tanya Reinhart

The Innateness of Binding and Coreference

Grimshaw and Rosen (1990; henceforth GR) have recently argued that the standard binding theory, as formulated in the Government-Binding (GB) framework, is innate. Results indicating that children do not know the coreference aspects of the standard binding theory are due to performance factors that mask this knowledge, leading, in GR's opinion, to the poor scores on tasks that supposedly test it. We will argue that the acquisition findings GR discuss do not lead to the conclusions they reach. Rather, they directly support the view, proposed by Reinhart (1983), that coreference and binding are not governed by the same module. Children do indeed suffer from a processing deficiency, where the coreference module is concerned; but under our analysis, it is directly traceable to the procedures required for computing coreference. This limitation is also detectable in other tasks given to children and in agrammatic aphasics. We will conclude that only under the analysis proposed here can it be shown that both the binding theory and the coreference rule are, indeed, innate.

1 Acquisition Findings and Their Possible Interpretations

Virtually all studies of the acquisition of anaphora have found no evidence that children know the coreference aspects of the binding theory (for a detailed survey and references, see GR 1990). This contrasts with their mastery of the conditions governing the interpretation of pronouns as bound variables. The clearest instance of the latter is Condition A, since lexical anaphors are interpreted only as bound variables (Chomsky 1982). All the studies dealing with this condition have shown that children know it quite early. As for Condition B, the first studies (e.g., Wexler and Chien 1985) focused only on coreference tasks and found that in sentences like (1a), children choose the coreference option about 50% of the time; that is, they perform around chance level.

(1) a. Oscar touches him.
b. Every boy touches him.

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These early findings thus led to the conclusion that children do not know Condition B. However, later studies by Chien and Wexler (1991a) discovered a distinction between children's performance on the coreference aspects of Condition B and their performance on its variable-binding aspects. It was found that when variable binding is tested, as in the case of (1b), children disallow anaphora, performing essentially as well on Condition B as they do on Condition A. Taken together, then, these two studies lead to the conclusion that children know Condition B, if this condition is viewed, following Reinhart (1986), as a condition on variable binding and not on coreference. Exactly the same results—a distinction between variable binding and coreference—have been found in the case of language loss (Grodzinsky et al. 1989). As for Condition C, many (though not all) studies have obtained the same results as the studies on the coreference aspects of Condition B; that is, children perform around chance level on coreference ruled out by Condition C. (For references, again see GR 1990; we discuss these findings in more detail in section 3.4.)

However, an interesting alternative interpretation of the experimental results has been proposed by GR (1990). They argue that a distinction is needed between knowing a linguistic rule and obeying it, and that the experiments indicate knowledge of the relevant binding conditions. This conclusion is based both on an experiment of their own and on reanalysis of the findings of existing studies. To appreciate their point, let us look briefly at the standard experimental settings used to investigate Condition B.

In most experiments the target sentence is preceded by, or embedded in, a context sentence, which also provides an antecedent for the pronoun. The two major contexts used in the experiments are illustrated in (2) and (3), where the italicized clause is the target sentence.

(2) a. This is A. This is B. *Is A washing him?*

Options

b. A washes A

c. A washes B

(3) a. B says that *A should touch him.*

Options

b. A touches A

c. A touches B

The experiments fall into two major types. In the "act-out" type, children are requested to act out the content of the target sentence, thus reflecting their choice of value for the pronoun. In the "grammaticality judgment" type, children are asked to say (or perform a task that indicates) whether a sentence (2a)/(3a) correctly describes a picture (2b–c)/(3b–c). Following Crain and McKee (1986), GR argue that the second method is superior to the first. Furthermore, they point out, if this method is employed, it is possible to compare children's performance on sentences ruled out by the binding theory to their

performance on sentences that are BT-grammatical. For example, sentence (2) can be tested twice: once with a picture corresponding to its grammatical interpretation (2c), and once with a picture corresponding to its ungrammatical interpretation (2b). Next, GR argue that all previous conclusions were based on checking only one aspect of experimental situations like (2), namely, that in responding to picture (2b), children accepted it as correct in close to 50% of the cases, in violation of Condition B. However, a fact that was previously ignored is that in the case of (2c), which does not violate Condition B, the children's performance level was well above chance; in fact, they accepted this interpretation in close to 100% of the cases. To buttress their claim, GR conducted an experiment of their own, with this result, consistent with previous findings (Chien and Wexler 1991a). Although GR illustrate their point only with contexts of the type in (2), it is, of course, crucial for their claim that the same is true for the context in (3).[1]

Given these results, GR note that the crucial comparison should be, not the one that has been made all along between (2c)/(3c) and Condition A cases, but the one between performance on the grammatical case (2c)/(3c) and performance on the ungrammatical case (2b)/(3b). They correctly point out that lack of knowledge of a grammatical principle should lead to identical performance on both the "grammatical" and the "ungrammatical" versions of the experiment. They claim that the fact that in grammatical sentences children make less than half the mistakes they make in ungrammatical ones (or, rather, the fact that they give many more "yes" responses) indicates that they are sensitive to the difference in the grammatical status of these two types. This leads them to conclude that children know all aspects of Condition B (including coreference). Other, independent considerations may explain why children seem not to "obey" Condition B in the ungrammatical cases, and why they perform better on Condition A and on the variable-binding cases of Condition B, than on the coreference cases.

This analysis is theoretically interesting since it calls into question the standard, commonsense expectation that there should be no difference in children's performance on interpretations ruled in and ruled out by a given grammatical principle (unless it can be shown that applying the principle involves different procedures for ruling derivations in and out). GR's approach supposes that if children's performance differentiates between grammatical and ungrammatical cases, then this, in and of itself, indicates that they know the rule in question. Although innovative, this conclusion is not the only logical possibility. Alternatively, when uneven results of the sort pointed out by GR are discovered, they may call into question the relevant linguistic generalization.

We will argue that the reason why children (and aphasics) perform differently on the (b) and (c) cases of (2) and (3) is that these two are not related by any linguistic rule. Since what is at stake here is the question of how competing analyses cut the experimental pie, or how they decide which sentences check which rule, we must first outline the analysis of binding that we assume. This analysis was originally proposed in Reinhart

[1] We base our assumption on (30) in GR's appendix, and on findings by others. See below.

1983, 1986; some technical aspects of the analysis were modified in Reinhart 1991, to resolve problems discovered in the original formulation over the years. In section 2 we summarize the analysis, following its presentation in Reinhart 1991.

2 Anaphora

2.1 Binding and Coreference

It is well known that in the case of lexical pronouns, *anaphora* (or *coindexing*) can mean two different things. In one sense, traditionally called *coreference*, it establishes a relation between the pronoun and some referential (or discourse-reference) antecedent, as in (4)–(5); in the other, it is the interpretation of the pronoun as a bound variable, as in (6)–(7). We use the term *coreference*, here and throughout, under its standard interpretation in the binding theory of the GB framework. As stressed by Chomsky (e.g., 1981:314), reference is to be taken here not as an object in the world but as a fixed value in some domain. Coreference is viewed as intended coreference; that is, this type of anaphora interpretation defines a relation between linguistic structures and their potential use for the purpose of expressing referential intentions. (See also Higginbotham 1980 and Lasnik 1981, 1989, although the precise interpretation of coreference is not crucial for our present purpose.)

(4) a. Lucie$_i$ adores her$_i$ friends.
    b. Alfred$_i$ thinks he$_i$ is a great cook.
(5) a. Most of her$_i$ friends adore Lucie$_i$.
    b. A party without Lucie$_i$ annoys her$_i$.
(6) a. Every actress$_i$ adores her$_i$ friends.
    b. Every scholar$_i$ thinks he$_i$ is a great cook.
(7) a. *Most of her$_i$ friends adore every actress$_i$.
    b. *A party without every actress$_i$ annoys her$_i$.

As illustrated by the contrast between (5) and (7), the syntactic environments allowing coreference are not identical to those allowing bound variable anaphora. Generally, bound variable anaphora is possible only when the antecedent c-commands (binds) the pronoun. Under the standard view of the binding theory (taken for granted, for instance, by GR), coreference is the central problem. It is believed that the coreference options of pronouns (marked by coindexation) are fully determined by the binding conditions. Consequently, the binding conditions have been construed so as to allow the coindexing in all the structures above. This yields the correct result for (5), but an incorrect result for (7). It is then assumed that (7) reflects some peculiar property of quantification in natural language, formulated as the Bijection Principle, which filters (7) out at LF.[2]

[2] This principle prohibits an operator from locally binding more than one variable. A locally binds B iff A is the only binder of B; that is, there is no intermediate C that is bound by A and binds B. After QR applies to (6a), the operator *every* locally binds the trace of *every actress*, but not the pronoun *her*, since the pronoun

This mapping of the facts, which takes (7) to be the marked case, specific to quantification, is purely theory dependent. One could just as well conclude that the binding rules determine the conditions allowing bound variable anaphora, which is impossible in both (5) and (7), whereas coreference is governed by a different module as a peculiar property of reference resolution in natural language. The main reasons that coreference has been taken as the unmarked case, rather than variable binding, are purely historical. Research on anaphora in linguistic theory started with questions of coreference (e.g., Lees and Klima 1963, Langacker 1966). (The bound variable interpretation of pronouns was discovered only later.) It seemed obvious at the time that the new binding theory proposed in the GB framework should capture everything that previous analyses did, so the coreference facts inherited their central status from previous analyses. It followed that if (5) is allowed, (7) should be treated separately.

However, a closer look at the way the binding theory has developed reveals that coreference is, in fact, the exceptional case. More precisely, pronouns have the property of being able to choose their reference freely from the discourse. This distinguishes them from all other anaphoric elements, illustrated in (8), that are currently governed by the binding theory.

(8) a. Lucie$_i$ adores herself$_i$.
b. Who$_i$ t_i smiled?
c. Felix$_i$ was fired t_i.
d. Alfred$_i$ promised PRO$_i$ to cook well.

Except for (referentially used) pronouns, all anaphoric elements share the same syntactic generalization: to be interpretable at all, they must be syntactically bound, that is, coindexed with a c-commanding antecedent. This is the same generalization that allows a pronoun to be a bound variable. (We ignore here the issue of the precise interpretation of arbitrary PRO.) In other words, only pronouns can enter into anaphoric relations without binding, as in (5), and even then, only if their antecedent is referential. It is the ungrammaticality of (7), then, that conforms with the general requirement on anaphoric relations.

All of the anaphoric elements in (8) also share a semantic property: they are all interpreted as bound variables. Although in the GB framework this has been explicitly stated only for reflexive anaphors and *wh*-traces (Chomsky 1982), there is no reason why it should not be extended to control PRO.

In view of this development of the binding theory, and in view of other facts we

is bound by the trace. In (7a–b) the same operator locally binds both the trace and the pronoun, since the trace does not c-command the pronoun. The Bijection Principle was proposed by Koopman and Sportiche (1982) and subsequently adopted in the GB framework. As Koopman and Sportiche observe, it is essentially equivalent to the generalization, proposed by Reinhart (1976), that a bound variable must be c-commanded by its antecedent at S-Structure. Although the Bijection Principle successfully filters out the derivations in (7), bear in mind that there is nothing "semantic" about it; in other words, it is not reducible to any independent logical property of operators.

will turn to later, Reinhart (1983, 1986) argues that the binding conditions regulate only bound variable anaphora. Coreference is computed separately, in a way to be discussed in section 2.3. Pronouns do fall under the binding conditions, but only with respect to their bound variable interpretation. Contrary to the assumptions underlying the analysis of (7), this is not at all an option peculiar to quantification structures. In fact, whether or not an anaphoric pronoun may be a bound variable is completely independent of the semantics of its antecedent. A sentence like (4b), repeated in (9), where the coindexation is taken to mark coreference in the GB framework, is still formally ambiguous between the two readings (9a) and (9b).

(9) Alfred$_i$ thinks he$_i$ is a great cook.
   a. Alfred (λx (x thinks x is a great cook))
   b. Alfred$_i$ (λx (x thinks he$_i$ is a great cook))

In (9a), where the pronoun is construed as a bound variable, it is the property of considering oneself to be a great cook that is attributed to Alfred, whereas in (9b), the coreference interpretation, it is the property of considering Alfred to be so. Obviously, these two interpretations are equivalent. However, there exist contexts in which they are not equivalent, as (10) and (11) illustrate.

(10) Alfred$_i$ thinks he$_i$ is a great cook, and Felix does too [e].
(11) Only Alfred$_i$ thinks that he$_i$ is a great cook.

The "sloppy" reading of the elliptic VP in (10) is obtained by copying (9a), and the identity reading by copying (9b). Similarly, (11) is ambiguous with respect to whether the predicate in (9a) or in (9b) is attributed to Alfred only.

This does not mean that anaphoric pronouns can always be bound variables. To be identified as such, they must conform to the syntactic generalization given above. The coreference cases in (5), where the pronoun is not syntactically bound, lack the bound variable reading. Consequently, placed in the same contexts as (10) and (11), they remain unambiguous:

(12) Most of her$_i$ friends adore Lucie$_i$ and Zelda too.
   a. Lucie's friends adore Zelda
   b. NOT: Zelda's friends adore Zelda (Zelda (λx (x's friends adore x)))
(13) A party without Lucie$_i$ annoys her$_i$, and a party without Zelda too.
   ONLY: A party without Zelda annoys Lucie
(14) Most of her friends adore only Lucie.

What it does mean is that pronouns may be bound variables in all and only the environments where the binding conditions allow them to be syntactically bound, regardless of the semantics of their antecedent. We are claiming that only this use of pronouns is governed by the binding theory.

2.2 The Binding Theory

Let us summarize, then, the view of the binding theory proposed by Reinhart. Although there are several equivalent ways to formulate it, it can also be presented simply as a reduced version of the standard binding theory:

(15) a. *Definition*
A node α is *bound* by a node β iff α and β are coindexed and β c-commands α.

b. *Conditions*
A. An anaphor is bound in its governing category.
B. A pronoun is free in its governing category.

c. *Translation definition*
An NP is a variable iff either
i. it is empty and Ā-bound, or
ii. it is A-bound and lacks lexical content.
Other cases of NP coindexation are uninterpretable.

The precise formulation of Conditions A and B is not important for present purposes. We use here the standard formulations given in (15a–b), but our analysis is unaffected if they are replaced with the Reflexivity Conditions A and B proposed by Reinhart and Reuland (forthcoming). As in the standard binding theory, NPs are generated with free indices, which may be identical (yielding coindexation, as in (16)). Some of the coindexed derivations (e.g., (16a–b)) are filtered out by Conditions A and B. Condition C is not assumed here to be part of the binding theory.[3] The interpretation of surviving indices at LF is governed by the translation definition in (15c), which is just a reduced version of the definitions assumed, independently, in the standard binding theory.[4] The basic assumption of this approach is that the only interpretation of coindexation is the bound variable one. Coindexation that cannot be so interpreted has no interpretation.

(16) a. *Everyone$_i$ thinks that Lucie admires himself$_i$.
b. *Everyone$_i$ bores him$_i$.
c. Everyone$_i$ thinks that Lucie admires him$_i$.
d. Everyone$_i$ bores himself$_i$.
e. Everyone$_i$ tried PRO$_i$ to sneeze.

[3] As argued by Reinhart (1983), Condition B must be assumed as a necessary part of the binding theory. In (16b) the coindexed pronoun is bound. Hence, if it were not filtered out by Condition B, (15c) would allow it to be translated as a variable. For this reason, attempts to extend Reinhart's analysis to eliminate Condition B as well (such as Burzio 1988) cannot really work.

[4] The standard binding theory (Chomsky 1981, 1982) assumes clause (i) of (15c) and, instead of clause (ii), a detailed list of the interpretive definitions of the various coindexed NPs: lexical anaphors are variables; pronouns are "intended coreferential" iff coindexed with a referential NP and are variables otherwise; R-expressions that are not empty and Ā-bound are "referential" (i.e., nonvariable); and so on.

f. *Everyone$_i$ hoped that the bastard$_i$ would win.
g. *He$_i$ hoped that everyone$_i$ would win.
h. *His$_i$ friends adore everyone$_i$.
i. *A party without everyone$_i$ upsets him$_i$.

(15c) takes the crucial property determining the interpretation to be syntactic binding. It defines all A-bound anaphors, pronouns and empty nodes alike, as variables: since such NPs do not have lexical content (though they may have ϕ-features), their translation as variables does not leave anything untranslated. Thus, the anaphoric expressions in (16c–e) are all interpreted as bound variables. Given (15), a full lexical NP (R-expression) may be syntactically bound, as in (16f–g), since Condition C is not assumed. However, it is not translatable by (15c).[5] The pronoun in (16g) is also untranslatable, since it is not bound, so this coindexation, like that of (16f), has no interpretation.[6]

Note, finally, that (15) eliminates the need for the Bijection Principle. (16h–i), which were found to require this principle (in the discussion of (7)), are precisely the cases where the coindexed pronoun is not bound. Hence, it cannot be defined as a variable by (15c), so the coindexing has no interpretation. The way (15c) is stated here, it can apply either at S-Structure or at LF; if it applies at LF, it is precisely equivalent, in the way it rules out weak crossover, to the Bijection Principle.[7]

It follows from (15) that anaphors can never be used referentially: Condition A allows their occurrence only when bound, and if bound they must be translated as variables. Thus, this property of anaphors, assumed in the GB framework, need not be stipulated separately.[8] Pronouns, by contrast, are never required to be bound. Hence, they can be freely used referentially.

[5] Although, for clarity, (15c) stipulates that absence of lexical content is a prerequisite for the variable translation, this is an obvious and independently assumed fact, since translating a lexical NP as a (bare) variable would entail eliminating lexical content.

[6] The system in (15) cannot distinguish "strong crossover" structures such as (16g) from "weak crossover" structures such as (16h). However, Chomsky (1982) argues that the former are also ruled out independently of the binding theory, as involving a governed PRO at LF. Alternatively, Reinhart and Reuland (forthcoming) suggest that strong crossover also violates, at LF, their version of the Chain Condition. Under both accounts, strong crossover is ruled out "twice" in our system, which is why it is worse than weak crossover.

[7] (15c) is not identical to the translation procedure proposed by Reinhart (1983, 1986), which, crucially, applies at S-Structure. (The difference between the two approaches surfaces mainly in structures where *wh*-movement applies.) It is stated here in such a way as to yield results equivalent to those of the Bijection Principle, which enables it to apply after (or before) QR. Consequently, it suffers from the same problems as the Bijection Principle. Most notably, both incorrectly rule out resumptive pronouns, as in the Hebrew (i).

(i) kol šaxen še+ha+raaš mealav hifria lo kara lamištara.
every neighbor that the noise above him bothered him called (to) the police

(Both pronouns are Ā-bound, but are not empty; thus, (15c) provides no translation for these pronouns. The Bijection Principle rules them out since one operator locally binds two variables.) However, since these details have no bearing on the present article, we can ignore them.

[8] The assumption that anaphors are only bound variables has at times been challenged. To give an early example, Sag (1976) reported that (a minority of) his informants could obtain strict (referential) interpretation for anaphors in contexts of VP ellipsis. In principle, it is possible to formulate Condition A so that it does not have this effect. In fact, the formulation suggested by Reinhart and Reuland (forthcoming) allows anaphors to be free under certain circumstances, in which case they can be referential. Nevertheless, as they are defined

Though the binding theory was illustrated in (16) with quantified antecedents, it yields identical results when the antecedent is referential. Although the coindexation in (4) and (6) is translatable, (15) provides no interpretation for the coindexation in either (5) or (7) ((5a) and (7a) are repeated, with no indices, in (17)), which accounts for the fact that (5) (represented here by (17a)) does not allow the bound variable reading, as shown in (12)–(14).

(17) a. Most of her friends adore Lucie.
b. Most of her friends adore every actress.

Since the pronouns in these sentences cannot be translated as bound variables, they must be interpreted referentially, choosing some reference from the context. In (17a) this may still be the value of *Lucie*, which yields a coreference interpretation. The only difference between quantified and referential antecedents is that the coreference interpretation is allowed only with the latter—a referential pronoun cannot choose a QNP as its value. This, however, is obvious. Lacking a reference, a QNP cannot enter coreference relations with anything.

2.3 The Coreference Rule

As noted in the discussion of (9), coindexation is ambiguous in the standard binding theory, representing both coreference and bound variable interpretation. Since our theory allows coindexation to be interpreted only as bound variable anaphora, we are left with the question of how coreference is to be captured. Reinhart (1983, 1986) argues that the coreference interpretation is not obtained by means of syntactic coindexing at all. Rather, it is just a subcase of the broader process of reference resolution. To assign a pronoun a reference mentioned in a previous sentence, it is clearly not necessary, and usually not assumed, that the two are syntactically coindexed. There is no principled reason why things should be different when a pronoun is assigned a reference mentioned in the same sentence. The central distinction we draw is that between sentence-level anaphora, which is captured by syntactic coindexation, and discourse-level anaphora. Although we follow the tradition of calling the second *coreference*, one of the insights of the Discourse Representation Theory (e.g., Heim 1982) is that quantified NPs may also display this type of anaphoric relation. The only point crucial for our discussion is that discourse-level anaphora cannot be sensitive to the sentence-level conditions on syntactic coindexation. We assume, then, that *coreference is the assignment of identical values to NPs with distinct syntactic indices*, regardless of whether the two NPs occur

in that framework, they cannot be deictic. Their referentially dependent nature follows from their internal analysis, but the fact that they are bound variables does not; the latter characteristic follows only from the binding theory. This means that, contrary to claims by Sells (1986), the system proposed here does not rule out the possibility of obligatory (unbound) coreference, but only rules out the possibility of its being enforced by the binding theory, or other syntactic conditions on coindexation.

in the same sentence or not.[9] This entails, for example, that in the ambiguous (9) (*Alfred thinks he is a great cook*) the coreference interpretation is obtained precisely when *he* and *Alfred* bear different indices. When they are coindexed, the bound interpretation is obligatory.

There is an obvious reason why linguists have also attempted to capture intrasentential coreference with coindexation: namely, that it appears to obey purely structural conditions. So far we have accounted only for the fact that in all the sentences of (18) no bound variable alternative is possible.

(18) a. Lucie_i adores her_k.
b. He_i adores Alfred_k.
c. He/Alfred_i thinks that Alfred_k is a great cook.
d. Alfred_i thinks that the guy_k is a great cook.
e. Most of her_i friends can't stand Lucie_k.
f. A party without Lucie_i annoys her_k.

We claimed that it is precisely when the pronoun is not bound that it can enter coreference relations. Why, then, is coreference impossible in (18a–d)? In the standard binding theory, where coreference is captured by syntactic coindexation, this problem does not arise, of course: for (18e–f), the standard binding theory allows alternative derivations, where the two NPs are coindexed, but if the NPs were coindexed in (18a–d), the sentences would be ruled out as ungrammatical by Conditions B and C.

But despite the apparent success of the syntactic coindexation approach in handling (18), it faces many problems, which we should look at before providing our treatment of these constructions. Theoretical problems with interpreting the GB indexing system are discussed by Evans (1980) and Reinhart (1983). Here we will mention only some of the empirical problems, which are discussed in greater detail by Reinhart (1983).

As has been widely observed, when coreference is involved, apparent violations of Conditions B and C can be perfectly grammatical, as in (19). (For convenience, we indicate coreference with italics and its inappropriateness with a star.)

(19) a. (Who is this man over there?) *He* is *Colonel Weisskopf*.
b. Only *Churchill* remembers *Churchill* giving the speech about blood, sweat, toil, and tears. (Fodor 1975:134)
c. Everyone has finally realized that Oscar is incompetent. Even *he* has finally realized that *Oscar* is incompetent. (Evans 1980:(52))

[9] We leave open here the precise details of this procedure, since they are independent of our central point, which is compatible with several available hypotheses. An attractive approach for capturing coreference as a specific case of sameness of variables has been developed by Heim (starting with Heim 1982), where the lexical content of the NP is interpreted as a (presupposed) restriction. (Among its many advantages, this approach may allow us to assign special treatment to (19a), which seems potentially different in status from the other examples in (19).) To allow this type of interpretation within our system, a (discourse) procedure can be constructed that coindexes syntactically distinct NPs. The syntactic indices, which play a role only in the syntax, are no longer relevant at this stage. Crucially, this procedure cannot be sensitive to the syntactic binding conditions, but only to our rule (20).

d. I know what Ann and Bill have in common. She thinks that Bill is terrific and *he* thinks that *Bill* is terrific. (adapted from Evans 1980:(49))
e. I dreamt that I was Brigitte Bardot and *I* kissed *me*. (due to George Lakoff, discussed in Heim 1991)
f. *Oscar is sad. *He* thinks that *Oscar* is incompetent.

Several attempts have been made to accommodate such facts within the syntactic approach, but each proposal either captures only one of the examples in (19) or overgenerates dramatically—failing to explain why violations of Condition C are not always possible. For example, if nondependent coreference is possible when there is a previous antecedent in the discourse, as Evans proposes to account for (19c–d), why is it not possible in (19f) as well?[10]

Reinhart argues, therefore, that the constraint on intrasentential coreference cannot be syntactic. Rather, it involves an inference based on knowledge of grammar, meaning, and appropriateness to context. The relevant generalization can be stated as the rule in (20), which replaces both Condition C and the coreference residue of Condition B. For convenience, (20) is stated as a noncoreference rule, though it could equally well be stated as a rule determining when coreference is possible. ((20) is slightly simplified for ease of presentation. See footnote 11 for the precise formulation.)

(20) *Rule I: Intrasentential Coreference*
NP A cannot corefer with NP B if replacing A with C, C a variable A-bound by B, yields an indistinguishable interpretation.

The intuition behind (20) is that if the structure could allow bound variable anaphora, coreference is preferred only if it is motivated—in other words, only if it is distinguishable from bound anaphora. We assume that (20) checks constructions at LF, rather than at S-Structure. Accordingly, *C* is not a linguistic expression but a variable. *A* is an expression that was not translated as a bound variable (if it had been, the coreference issue would not arise). (20) checks whether in the given LF representation it is possible to replace A with an A-bound variable C, which (given the definition of binding in (15a)) would be possible only if B c-commands A at S-Structure.[11]

Let us illustrate first how (20) draws the distinction needed in (18) (repeated here) between structures that freely allow coreference and those that do not.

[10] Some of the strategies used in the GB framework to account for these problems are the following: Lasnik (1976, 1989) accounts for identity sentences in terms of presuppositions, an account relevant only for (19a); Higginbotham (1980) offers a syntactic account for *only*, which, if it were correct, would explain only (19b); Fiengo and May (1990) provide the latest example of overgeneration with their argument that noncoindexed coreference is always possible for two given NPs, as long as "it is not part of the meaning of the sentence that they are co-valued" (their linking rule). Like Evans, they do not consider why, for example, (19f) is not just as good as all the other cases of (19). Reinhart (1983) argues in detail that it is definitely part of the meaning of the (good) sentences in (19) that their NPs are "covalued," but that what is not part of their meaning is that the pronouns are bound variables.

[11] Following all the standard assumptions, this means that B and C must both be bound by the same operator, which is obtained by raising the antecedent (B) and introducing an operator. To avoid potential vagueness, (20) should be read only as follows:

(18) a. Lucie$_i$ adores her$_k$.
b. He$_i$ adores Alfred$_k$.
c. He/Alfred$_i$ thinks that Alfred$_k$ is a great cook.
d. Alfred$_i$ thinks that the guy$_k$ is a great cook.
e. Most of her$_i$ friends can't stand Lucie$_k$.
f. A party without Lucie$_i$ annoys her$_k$.

(18e–f) are structures that never allow bound anaphora; in other words, it is impossible to replace either *Lucie* or *her* at LF with a variable that will be A-bound by the other. Hence, (20) is never met in these structures, and they freely allow coreference. By contrast, in (18a–d) one NP is c-commanded by the other. Hence, in these structures it is always possible to replace the c-commanded free NP with a variable that will be A-bound by the higher NP (i.e., by its trace at LF; see footnote 11 for further details of how Rule I applies here). This replacement results in an LF representation with bound variable anaphora. For example, replacing *her* with an A-bound variable in (18a) yields *Lucie* (λx (*x adores x*)), and replacing *Alfred* in (18c) yields *He/Alfred* (λx (*x thinks that x is a great cook*)). Since a bound alternative exists in such contexts, coreference is highly restricted by (20). It is only allowed if the bound alternative is distinguishable from the coreference reading. As noted earlier (in (9)), when a sentence allows binding, the bound interpretation is equivalent to a coreference interpretation, so they are indistinguishable out of context. Hence, with no appropriate context (20) yields results identical to those of the standard Conditions C and B, and (18a–d) are ruled out.

However, in (19a–e) sentences with the same structural properties are provided with the appropriate contexts. What they all have in common is that the coreference

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(20′) NP A cannot corefer with NP B if replacing A, at LF, with a variable bound by the trace of B yields an indistinguishable interpretation.
(i) a. Lucie criticized herself.
b. Lucie$_i$ [e$_i$ criticized herself$_i$]
c. Lucie (λx (*x* criticized *x*))
(ii) a. Lucie criticized her.
b. Lucie$_i$ [e$_i$ criticized her]

For example: The LF representation of (ia) is (ib), translatable as (ic). An available LF representation of (iia) is (iib). If we replace *her* with a variable in (iib), it is c-commanded by e_i; hence, the representation (ic) is obtainable for this sentence, and (20′) allows coreference only if this representation is distinguishable from the coreference interpretation we would obtain if we assign *Lucie* and *her* in (iib) the same value.

(20) differs from the original formulation in Reinhart 1983, which took the relevant factor to be the availability of an alternative bound expression. Here the rule is based on the availability of semantic binding, regardless of the expression used for it. This change, discussed in Reinhart 1991, was motivated by an important problem raised by Lasnik (1989) for the previous condition, based on expressibility gaps: structures exist in which coreference is ruled out, though no grammatical alternative to express bound variable anaphora is available. For example, even though **Lucie and Max praised himself* is ungrammatical, coreference is impossible in *Lucie and Max praised him*. At present neither the standard binding theory nor Rule I can actually rule out coreference here. However, as argued in Reinhart and Reuland, forthcoming, in its semantic representation this sentence violates Condition B, if the pronoun and *Max* are coindexed. This means also that if Rule I applies at a more abstract semantic level than LF, a bound variable representation is available here. Although (20) is stated to apply at the syntactic level of LF, in the long run it should be possible to state it as a semantic rule, similar, perhaps, to the functional principle proposed by Bach and Partee (1980).

interpretation is distinguishable from a bound alternative. In some cases the distinction is plainly truth-conditional. In identity sentences like (19a) (*He is Colonel Weisskopf*), choosing the bound option results in a tautology (*He* (λ*x* (*x is x*))), which the coreference reading clearly is not. When *only* is involved, coreference and binding have different truth-conditions (as in (11)); hence, (19b) requires no special context to be justified. (This sentence is probably false, whereas its bound alternative is true.) The same is true for sentences with *even*, such as (19c), if we view presupposition differences as part of the sentences' truth-conditions. In (19e) *I kissed me* is permissible, since the alternative bound anaphora reading *I* (λ*x* (*x kissed x*)) would involve some self-kissing event, which is apparently not what Lakoff dreamt about.[12] In other cases what is meant by *distinguishable* may be more subtle. In (19d) the question is which property is shared by Ann and Bill. Although when applied to Bill the property of finding Bill terrific is indistinguishable from that of finding oneself terrific (which is the interpretation of the bound version), strictly speaking, the property shared by both Ann and Bill is only the first, so a speaker may choose to be very precise here. When the two readings cannot be distinguished, as in (19f), previous mention of the reference cannot help and (20) rules out coreference.

In structures where both coreference and binding are in principle possible, such as (9), repeated in (21), (20) has the effect of allowing coreference (for (21a)) only in contexts where it is distinguishable from the bound interpretation.

(21) a. Alfred_i thinks he_k is a great cook.
b. Alfred_i (λ*x* (*x* thinks *x* is a great cook))

This is so because it is always possible to replace the free pronoun in such structures with a bound one, in this case yielding (21b). Since in all other contexts the two readings are equivalent anyway, this seems to us unproblematic, though Rule I can also be stated in a way that does not have this effect.[13]

[12] This example was not discussed in Reinhart 1983, but its relevance to Reinhart's analysis was pointed out in (early drafts of) Heim 1991.

[13] If one wants to distinguish cases like (21) from those in (19), another clause can be added to (20):

(20″) NP A cannot corefer with NP B if *A could not be bound by B, and* replacing A, at LF, with a variable bound by the trace of B yields an indistinguishable interpretation.

(Under this view of Rule I, it requires special justification for the coreference choice only when there is a visible avoidance of binding (indices being invisible).) Since in structures like (21) the pronoun could always have been bound, such structures will never be prohibited by Rule I and the coreference reading will be freely allowed independently of context. The reason why this may seem desirable is that it is much easier to obtain a (distinguishable) coreference reading in such structures than in those of (19). For example, it has been noted by an *LI* reviewer (and others) that ellipsis contexts, though disambiguating the bound and the coreference reading, do not seem sufficient, in the absence of other contextual factors, to license coreference that would be ruled out by the standard binding theory Conditions B and C. So (ia) is not particularly good, though the addition of *himself* in (ii) improves it.

(i) a. He still expects Weisskopf/him to win, but no one else does anymore.
b. He thinks that Weisskopf is a war hero, but no one else does.
(ii) He himself still expects Weisskopf/him to win, but no one else does.
(iii) Weisskopf thinks he is a hero, but no one else does.

The idea behind Rule I is that in the standard cases the easiest way to express coreference is by means of binding. When this option is avoided without the relevant motivation, lack of coreference intention is inferred. We leave open whether Rule I is an independent principle of the coreference module of Universal Grammar or whether it may be reducible to other general principles.[14] If it can be shown that computing a reference twice, as in the coreference interpretation, is more costly than computing it once, as in the binding interpretation, Rule I could be related to the Least Effort Principle.

2.4 Objections and Replies

Let us now address the objections raised by GR (and others) to Reinhart's analysis.

An argument often raised (mistakenly) against Rule I, which is repeated by GR, is that it presumably should block anaphora of the pronoun in the contexts of (22) (GR's (20)), since in these contexts an anaphor can be bound.

(22) a. John enjoys most stories about him/himself.
b. She pulled the blanket over her/herself.

However, this is clearly a problem for the current binding theory and not for Rule I. Recall that Rule I governs only coreference and not bound anaphora. Whether an anaphoric expression can be bound in a given context depends solely on the binding theory, and if the binding theory allows more than one anaphoric expression to be bound in the same context, Rule I has no say on the matter. (In this respect, Reinhart's analysis differs from some recent adaptations of it, such as Burzio's (1988).) In the contexts shown in (22) both a pronoun and an anaphor can be grammatically bound, as witnessed, for example, by the fact that both are interpretable as variables bound by the QNP operator in (23).

(23) a. Every boy enjoyed most stories about him/himself.
b. Every lady pulled the blanket over her/herself.

The familiar formulation of Conditions A and B cannot account for this fact. A reformulation that accounts for the context (22a), though not (22b), has been proposed by Chomsky (1986). Another formulation, which accounts for both contexts of (22), as well

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We cannot account for the difference between (i) and (ii), which probably requires a deeper understanding of discourse and intonation properties than we have. But the more crucial contrast, which clearly needs to be explained, is that between (ib) and (iii), which does not require any accommodations to allow coreference. This would follow, if (20) is modified as above.

However, since we are talking here about processing anaphora in discourse, we are not sure that the same would not also follow without this modification. Given our binding theory and Rule I, when trying to establish anaphoric relations, a person hearing (iii) first opts for binding, unless coreference turns out to be distinguishable from binding, whereas a person hearing (iib) first opts for noncoreference, unless coreference turns out to be distinguishable from binding. Whereas the move from binding to coreference is just a choice between two equivalent representations, the move from noncoreference to coreference involves a substantial meaning change, which should be harder.

[14] Attempts at such a reduction can be found in Levinson 1987 and Ariel 1990.

as the noncomplementarity of pronouns with long-distance anaphors, is discussed by Reinhart and Reuland (forthcoming). Whatever the correct formulation turns out to be, it is clear that Rule I cannot block bound anaphora of the pronoun in (22).

It remains to determine only whether the coreference reading (as distinct from the bound reading) could be blocked by Rule I. In this respect, (22) is identical to (21) (*Alfred$_i$ thinks he$_k$ is a great cook*). Since in both cases the unbound pronoun could be replaced with a bound variable, coreference is allowed only when the context makes the readings distinguishable (and if they are not, it does not matter, since the bound version is equivalent). (See also footnote 12.)

The same issue arises in the case of long-distance anaphors, which are not in complementary distribution with pronouns (see, for example, Reuland and Koster 1991). Although there is no agreement yet on how to capture this fact, it is clear that the binding theory should be stated so as to allow it (since both function as bound variables in these contexts). Once this has been done, Rule I is irrelevant for these contexts, except, again, for the cases where we are specifically interested in coreference, as distinct from binding. In these cases Rule I applies precisely as it does in (22).

A more interesting argument that GR raise against Rule I is that it would appear to incorrectly allow coreference in (24a) (their (21)).[15]

(24) a. **Many students* expect *them* to leave.
b. Many students expect themselves to leave.
c. many students (λx (x expects x to leave))
d. Many students expect that they will leave.

The argument rests on the assumption that the ambiguity between the collective and distributive interpretations of plural pronouns, which is found, for example, in (24d), is reducible to the distinction between referential and bound pronouns, where the latter corresponds to the distributive reading.[16] This view is supported by the belief that plural anaphors that allow only the interpretation in (24c) can have only the distributive interpretation. (24c) is also the interpretation that results from replacing the pronoun in (24a) with a variable, so it would seem that Rule I should allow coreference in (24a), under the collective interpretation of the pronoun, which is distinguishable in this case from the bound variable (distributive) alternative.

This inference is valid, though, only if it is indeed true that the ambiguity in question is reducible to the referential versus bound distinction. Appealing as this idea may sound, it cannot really be true, in view of cases like (25).

(25) a. Ben and Lucie consider themselves a perfect couple.
b. Ben and Lucie expect themselves to be a perfect couple.

[15] The argument, attributed to Chomsky, was raised against the earlier statement of Rule I given in Reinhart 1983. We reformulate it here so that it also applies to the current statement of the rule.

[16] This view was proposed by Williams (1986).

c. Ben and Lucie consider themselves a perfect couple and Max and Lili do too.
d. Ben and Lucie (λx (x consider x a perfect couple)) and . . .

In fact, the anaphors in (25) have only the collective reading. (Under the distributive interpretation, (25a), for example, should entail that Ben considers himself a perfect couple.) Since anaphors are assumed to allow only the bound variable reading, the ambiguity must reside in that reading. We can verify that the bound variable reading indeed also carries a collective interpretation by looking at (25c). The only reading available for the elliptic conjunct is the bound one (Max and Lili consider themselves a perfect couple), which must be obtained via an LF representation of the type shown in (25d); nevertheless, the bound variable can only be collective here. This suggests that it must be possible to interpret bound variables as set (collective) variables. Whatever the details of such an analysis may turn out to be, (24b) must be ambiguous. So choosing an unbound pronoun instead, as in (24a), does not yield any interpretation that is not available with the bound version, and Rule I therefore does not license such a choice.

3 Cutting the Experimental Pie

Just as the mapping of facts is theory dependent, so is the design of experiments. Our reinterpretation of the findings regarding children's binding abilities is obviously based on the available data, and since most of the work in the field (except Wexler and Chien's) has assumed the standard binding theory, the experiments have been structured accordingly. Our account thus rearranges these findings, following the alternative theoretical framework just presented.

Once the findings regarding bound anaphora are separated from those regarding coreference, the acquisition results summarized in section 1 fall into a very clear pattern: children know all aspects of variable binding, and they perform equally well on grammatical and ungrammatical sentences governed by the binding conditions, as we stated them, which therefore provides impressive evidence that these conditions are innate. On the other hand, children uniformly perform at chance level in ruling out noncoreference governed by Rule I. We argue that under the assumption that children (and aphasics) suffer a specific processing limitation that interferes with the application of Rule I, we can maintain the null hypothesis that Rule I is also innate.

3.1 Pronouns and Roses: Irrelevant Comparisons

Recall that GR's conclusion that children do know the coreference conditions, precisely as formulated in the GB framework, is based on their observation that children perform differently on sentences ruled in and ruled out by these conditions. The comparison they employ is purely theory dependent, however, and in many of the pairs used in their experiments it turns out to be irrelevant under the analysis of anaphora proposed above.

Within the standard assumption—that the binding conditions also regulate corefer-

ence—the paradigm in (3), repeated in (26), falls under Condition B, which rules out interpretation (26a) but not interpretation (26b).

(26) B says that A should touch him.

Options

a. A touches A
b. A touches B

From this perspective, GR are correct in concluding that if children are significantly better at allowing coreference in (26b) than at disallowing it in (26a), this may be characterized as a difference in performance on sentences ruled in and ruled out by Condition B, corresponding to their distinction between knowing a rule and obeying it. However, from the perspective of the alternative theory, (26a) and (26b) are unrelated. (26a) is an instance of noncoreference, governed by Rule I, and (26b) is an instance of variable binding. Consider the child's behavior as predicted by this theory. When presented with option (26b), children—already knowing the binding theory—should know that the pronoun in this case can be bound. Although coreference is also possible, the two readings are indistinguishable (as noted in the discussion of (9)). However, children's performance on (26b) does not rely on their ability to compute coreference, since to accept (26b), it suffices that a bound variable interpretation is available in this context. Only in (26a) is knowledge of Rule I necessary. Children know that the pronoun in this case is not bound (because of Condition B), and only Rule I can tell them whether it can, nevertheless, be coreferential.[17]

The same point holds for Condition C. Consider, for example, two of the sentences tested in GR's own experiment:

(27) a. He_i said that $Bert_i$ touched the box. (GR's (29b))
b. $Bert_i$ said that he_i ran behind the box. (GR's (30b))

For the standard approach, assumed by GR, both sentences illustrate the operation of Condition C, with respect to which (27a) is ungrammatical but (27b) is grammatical. GR report that children respond correctly to the grammatical sentences at least twice as often as they respond correctly to the ungrammatical ones, on which they perform around chance level. They therefore conclude that children know Condition C. In our framework, however, the sentences in (27) are just as unrelated as the two options in (26). In (27b) the pronoun is interpretable as a bound variable. In (27a) it cannot be so interpreted,

[17] The other context used by GR to provide the grammatical counterpart of Condition B is intersentential coreference, as in (2), repeated here.

(i) This is A. This is B. Is A washing him?

Pictures

a. A washes A
b. A washes B

This contrast indeed falls under Rule I, which allows discourse coreference in (ia), but not in (ib). The difference in children's performance will follow from our analysis in section 3.3.

since it is not syntactically bound. Anaphora in (27b) thus falls under the binding theory, whereas the lack of coreference in (27a) is determined by Rule I.

In sum, then, (a) and (b) in (26) and (27) are governed by the same rule only if the coreference picture of the standard binding theory is assumed. If our analysis in section 2 is assumed instead, this contrast is no more relevant than testing children's understanding of the pair in (28) and attempting to draw conclusions from the fact that they understand (28b) correctly almost 100% of the time, but (28a) only around 50% of the time.

(28) a. Oscar washes him.
b. Roses are red.

In all of the pairs in (26)–(28), the (a) sentence checks Rule I, and the (b) sentence is irrelevant to this rule.

3.2 Knowledge of Binding

Given the analysis proposed in section 2, let us return to the standard expectation, according to which if children know the binding conditions, they should perform equally well on tasks involving sentences those conditions rule in and sentences those conditions rule out. Once the binding conditions are defined as governing only bound variable anaphora, the experimental results indicate quite clearly that this is indeed so. To see this, we need only separate the experimental findings that concern knowledge of the binding theory from those that concern Rule I. For convenience, we summarize these findings, most of which have already been mentioned in the previous discussion.

In our way of cutting the pie, the BT-grammatical sentences are the ones in (29). The anaphoric element in those sentences is translatable as a bound variable (since Condition A is observed in (29a), and since binding the pronoun in (29b) observes Condition B; recall the discussion of (27b)).

(29) *BT-grammatical sentences*
a. Oscar_i touches himself_i.
b. Bert_i said that he_i ran behind the box.
c. Bert_i said that Gert touched him_i.

Regarding (29a) there seems to be a universal result. In both act-out tasks and grammaticality judgment tasks (e.g., Chien and Wexler 1991a), children's responses are close to 100% correct. A similar consensus has been found concerning knowledge of binding in (29b), starting with results reported by Carol Chomsky (1969). Once corrected for the type of task that was used, the interpretation of the findings for (29c) leads to the same conclusion.[18]

[18] Several studies (e.g., Ingram and Shaw 1981, GR 1990) have tested (29b). Ingram and Shaw used a binary-choice question-answering task, where children had to choose between an anaphoric reading of the pronoun (with *Bert*—a c-commanding antecedent outside the governing category) or a deictic reading (with

BT-ungrammatical sentences are illustrated in (30), where (30a) violates Condition A and (30b) violates Condition B.

(30) *BT-ungrammatical sentences*
a. *Oscar$_i$ said that Bert touches himself$_i$.
b. *Every boy$_i$ touches him$_i$.

The reason why only these examples should be compared to those in (29) is that they do not, in principle, allow the coreference interpretation. For (30a), this is because reflexives are interpretable only as bound variables. For (30b), it is because the antecedent is quantified; hence, if the pronoun cannot be interpreted as a bound variable (as is the case, by Condition B), it does not have any other anaphoric interpretation. If children reject binding in these sentences, then there is no way they could still allow anaphora. In this way, these sentences differ from sentences with a referential antecedent (like those GR used), where coreference is, in principle, an option, for which Rule I must be consulted. Indeed, all available experimental studies on this issue demonstrate that in both cases of (30), children are just as able in blocking anaphora as they are in accepting licit anaphoric interpretations for (29) (see section 1, and Chien and Wexler 1991a, for a summary of these results).

We may conclude that if the standard binding theory, which mixes coreference and binding, is assumed, there is no evidence that children know it. But if it is defined as presented here, all the facts follow naturally, indicating that it is innate.

3.3 Knowledge of Coreference

The cases on which GR report that children performed poorly are all structures where our analysis claims that coreference is prohibited by Rule I, and not by the binding theory, as in (31). (As we mentioned in section 1, the same structures have also been widely observed by others, though in the case of the apparent Condition C violations (in (31b–c)) the findings are less consistent than in the case of (31a); we return to these findings directly.)

(31) *Rule I ungrammatical*
a. **Oscar* touches *him*.

an unmentioned antecedent—a puppet displayed in front of the child). Both readings are licit, of course; and indeed, children chose the anaphoric interpretation about 70% of the time, indicating their ability to bind, and providing a measure of their tendency to do so in this kind of task. Crucially, Rule I plays no role in guiding the child's decision here. This, however, is not the case in (29c). Although (29c) is similar theoretically to (29b), a binary-choice act-out task in this case presents children with a different problem. They must choose between two candidate antecedents, *Bert* and *Gert*. Choosing the former is permitted by Condition B (as well as Rule I), yet choosing the latter (a c-commanding antecedent inside the governing category) is prohibited by both Condition B and Rule I. In other words, children must use Condition B just as they used it for (29b) in choosing *Bert*, and they must rule out *Gert* by Condition B and Rule I. Here, too, children chose *Bert* as an antecedent about 70% of the time (in both Chien and Wexler's (1991a) and Solan's (1983) studies), conforming to the experiments regarding (29b); yet, unlike the situation they were faced with in (29b), where the other choice—a deictic use—was licit, here they had to use Rule I to rule out the local antecedent, and in this task they failed, choosing it erroneously in the remaining 30% of the trials.

b. **He* touches *Oscar.*
c. **He* said that *Oscar* touches the box.

In principle, it is possible that children know the binding conditions and do not yet know Rule I, since these two belong to independent modules. But before we draw this conclusion, we should check whether other accounts are available.

Let us assume that Rule I, just like the binding theory, is innate. For the time being we take it to be an independent rule belonging to the module governing coreference and anaphora resolution in discourse (though in the long run it may turn out to be just an instance of a more general principle of Universal Grammar). However, let us see what is involved in executing this rule, repeated here, in the case of noncoreference.

(20) *Rule I: Intrasentential Coreference*
NP A cannot corefer with NP B if replacing A with C, C a variable A-bound by B, yields an indistinguishable interpretation.

In order to decide whether Rule I allows the pronoun in (31a) to corefer with *Oscar*, children must first determine whether the pronoun can be replaced with a bound element. If it could not be, their task would be over and coreference would be allowed. But it is possible, in this structure, to obtain an alternative variable-binding interpretation (as would be the case in the LF representation of this sentence if a reflexive anaphor was used). The innate Rule I now requires children to do the following: While still holding the sentence under processing in memory, they must construct two representations, one for the binding option, and another for the alternative coreference reading. Next they must compare the two representations, relative to their context, in order to decide whether they are distinguishable. If they are, coreference is allowed; if they are not, it is ruled out. The same procedures apply to (31b–c), where it is the full NP *Oscar* that must be replaced with a bound element.

There is no known reason to assume that any of the steps requires knowledge that surpasses children's innate endowment. Children's innate semantics should enable them to distinguish between the interpretation of binding and the interpretation of coreference, and to correctly determine the truth-conditions of these cases in context. But the execution of all these steps, in the specific case of structures like (31), puts a much heavier burden on working memory than do other rules (e.g., the binding conditions). Thus, the need to hold and compare two representations surpasses children's processing ability. If this is so, then presented with (31), children know exactly what they are required to do by Rule I, but getting stuck in the execution process, they give up and guess.

Although we do not have a more detailed account of the exact nature of this limitation, it is clear that only Rule I–governed structures are beyond children's computational capacity. Moreover, there is independent evidence that supports this proposal. Recall from section 1 that agrammatic aphasics succeed in binding tasks and fail in coreference tasks just like children, indicating that they suffer a similar deficiency, which we interpret in the same way. If holding and comparing two representations is what

children and aphasics cannot do, there must be other tasks, whose demand characteristics are similar, on which these language-deficient populations will also fail. If such failures can be found, our processing claim will be generalized, gaining independent support. In fact, several studies, of both children and aphasics, have found exactly such failures.

Before we outline these studies, a short digression into psycholinguistic work with normal adults is necessary. In a well-known experiment, Swinney (1979) demonstrated that normal adults ignore context when accessing a word. He first presented his subjects a sentence containing an ambiguous word, with left context biased toward one of the readings:

(32) a. The FBI agent searched the room for BUGS.
b. He caught spiders, roaches and other BUGS.

Using a secondary priming task, he then demonstrated that people initially access all the meanings of an ambiguous word, regardless of context. In this experiment the sentences in (32) were presented auditorily. Immediately after the ambiguous word was spoken, a sequence of letters was flashed on a screen. This sequence was either a word related to the contextually relevant meaning (e.g., SPY), a word related to the other meaning (e.g., ANT), or a control sequence. Subjects had to decide whether or not the sequence of letters was a word, and their decision time was measured. The logic behind this task is that if subjects use context to preselect the relevant meaning, only the word related to it will be primed. Yet Swinney found the opposite. The subjects showed a priming effect for both meanings, indicating that the lexical access mechanism is encapsulated, and insensitive to contextual influences. The choice of the appropriate lexical item is made a few hundred milliseconds later; at this point only the contextually relevant meaning has a priming effect, indicating that other, irrelevant meanings have been suppressed.

Consider, now, what such a task involves. The subject must access two representations, hold them in memory for a short time, and quickly compare each of them to the context, to make the appropriate choice. This is precisely the kind of task for which our analysis makes a prediction. From a processing point of view, it is analogous to the application of Rule I.

Swinney, Nicol, and Zurif (1989) tested agrammatic aphasics on exactly this task, and Swinney and Prather (1989) tested children on a similar task. The results of the two studies were remarkably similar. Both children and aphasics showed a priming effect for only one of the meanings; yet surprisingly, it was not necessarily the one determined by context, but the one with the higher frequency of occurrence. If context were to have any effect at all, one would expect it to force the selection of the proper meaning, but here a completely irrelevant factor—frequency—surfaced and dictated which meaning would be primed.

Surprising as it is, this finding is perfectly consistent with our interpretation of the

experimental results from children and aphasics regarding Rule I. First, if Swinney et al.'s task requires holding two representations in memory in order to match them with context, then a priming effect for both meanings should not be expected, because this is exactly what these subjects cannot do. Second, a priming effect for the contextually relevant meaning should certainly not be observed, because this would mean that the subject had already made a choice, based on context, an operation that we claim these subjects are incapable of. Third, if there is an independent factor that affects priming generally, it is most likely to surface here. When normal adults are faced with Swinney's task, their mature, unimpaired language-processing device is capable of carrying out the full task, thereby masking any frequency effects. But in children and aphasics the system is deficient. They cannot hold both representations in memory for the purpose of comparing them with prior context, and thus, the experimental situation is reduced to the simplest form of a priming experiment. With a limited processing capacity such as theirs, the task does not involve the complications that it presents to normal adults, and becomes one that simply requires priming between an ambiguous word and a target (that is, between a word like BUG as the prime, and targets like ANT and SPY), without any context at all. Under such conditions it is not at all surprising that the only factor at play would be the one that always is (namely, frequency), because in such a task, when an ambiguous word is used for priming, it is well known that the more frequent meaning prevails. Thus, our processing claim is independently supported, and the (otherwise mysterious) parallelism between children and aphasics receives a natural explanation.[19,20]

Having established the evidential basis for our claims, it is important to examine an alternative account of the same findings, appealing to lack of knowledge of Rule I. Such an account has been proposed by Chien and Wexler (1991a), who argue that children do not know the principle governing coreference. We considered this possibility initially, and rejected it. Apart from encountering several theoretical problems (e.g., learnability, coverage of processing results), it makes a wrong prediction, which must lead to its abandonment: if children and aphasics do not know Rule I, they should accept as grammatical every sentence that this principle rules out. The data, however, show very clearly that in the judgment experiments, both populations perform at chance levels on these

[19] Swinney's finding, if correct, entails that children and agrammatics are unable to integrate an ambiguous word into sentential context, if the contextually relevant meaning is the less frequent one. Note, however, that this entailment is testable only in laboratory conditions, and in and of itself does not imply that children would be unable to understand sentences containing ambiguous words, even if these appear in their less frequent meaning. This is so because the meaning of an unknown word embedded within a sentence can often be reconstructed on the basis of contextual redundancy. Thus, even if the ambiguous word had not been accessed, the overall meaning of the sentence may still be easily recovered by the children and the agrammatic aphasics.

[20] Moreover, the data presented by Swinney, Nicol, and Zurif (1989) provide yet another perspective on the processing deficit: Wernicke's aphasics, who, on the judgment task, showed a performance pattern very different from that of the children and the agrammatic aphasics (see Grodzinsky et al. 1989), performed virtually normally in the lexical access experiment. This finding underscores the fact that the children's and the agrammatic aphasics' results on both tasks coincided, and strengthens the claim that the failure in both tasks always stems from one source.

sentences (i.e., they guess) rather than below chance (i.e., consistent acceptance rather than rejection), as this account would predict.

Assuming, then, that children know Rule I but cannot use it, it is appropriate to turn to the structures that it allows. Relevant examples, which are governed only by Rule I, are given in (33), where the pronoun cannot be bound.

(33) *Rule I grammatical*
  a. Before *Mickey* went to school, *he* fed the dog.
  b. The bear near *Lucie* touched *her*.
  c. Let's ask the bear that *Lucie* likes to kiss *her*.
  d. Some of *her* friends are upset at *Lucie*.

We should note that, except for (33a) (from Ingram and Shaw 1981; see also Solan 1983), no data are available on children's performance on such cases, since most of the acquisition experiments are based on the standard binding theory and tend to compare Rule I–ungrammatical sentences with sentences involving binding. So all we can do here is examine the logic of Rule I as applied to such structures. The processing load here is in no way comparable to that of the noncoreference cases in (31). To decide whether the pronoun can corefer with *Lucie* in (33b), the child must do more than in the cases of binding (such as *Lucie touched her bear*)—namely, check whether an alternative derivation with a bound element exists. However, unlike what happens in the noncoreference cases, once the child finds out that no such derivation does exist, Rule I already allows coreference and processing is completed, with no need to hold and compare the two representations to the context.

In the absence of empirical evidence, we are not aware of any reason to assume that the steps required here by Rule I are beyond the processing ability of a child. So (directionality effects aside) we would expect children to have no problems with Rule I–grammatical sentences. In the one structure that has been widely studied, (33a), this was found to be true.

Assuming the distinction between coreference and binding, then, nothing remains mysterious in the findings on anaphora acquisition. Children know both coreference and binding, and the problems they encounter with noncoreference are processing problems, of the sort known to diminish with age.

3.4 Further Notes on Condition C

So far we have followed GR's conclusion that children do not perform better on Condition C violations than on Condition B violations. However, this conclusion has at times been challenged in the acquisition literature. Since in our system the two conditions should pose equal processing difficulties to the child, a survey of the actual findings is important.[21]

[21] A branch of the study of Condition C that need not concern us here is that focusing on strong crossover (Lebeaux 1988, Crain and Thornton 1990, McDaniel and McKee 1990). Since the antecedent in such cases is

Starting with the work of Carol Chomsky (1969), the structures that have starred in acquisition studies have been the following:

(34) Bert said that he ran behind the box.
(35) **He* said that *Bert* touched the box.
(36) Because he heard a lion, Tommy ran fast.

In the standard approach, all three cases are governed by Condition C: that is, what distinguishes (35) is that it violates Condition C, whereas (34) and (36) do not. In our terms, (34), which repeats (29b), is a case of binding, and only (35) and (36) are governed by Rule I, involving an illegal and a legal application, respectively. The one thing that all studies agree on is that children clearly master anaphora in (34). But for the other two structures, which are the ones we are concerned with, it is extremely difficult to find a consensus on what the actual findings are.

Only one set of experiments, reported by Crain and McKee (1986), concluded decisively that, quite early, children successfully block coreference in (35) and allow it in (36), as would follow from Condition C.[22] GR report that in their experiment children accepted the ungrammatical coreference in (35) in 37.5% of the cases, which is not significantly different from their chance performance on Condition B violations. (GR did not check (36).) Many other studies have reported a higher rate of ruling out coreference in (35), which may appear to go against what we have been assuming, but the authors of these studies note that their subjects also ruled out the grammatical sentence in (36). They attribute both results to an independent directionality effect: children appeared to reject backward coreference, regardless of the grammar (to mention just a few: Tavakolian 1977, Solan 1978, Lust, Loveland, and Kornet 1980, Lust and Clifford 1982).

In view of this variety of findings, it is important to remember that the actual results depend greatly on the experimental methods used, so GR's methodological comments are very important in this respect. Nevertheless, it remains true that more agreement was reached concerning children's failure on Condition B ungrammatical sentences than concerning their failure on Condition C violations like (35). If the directionality effect exists, it may explain this difference, since it surfaces only in the case of Condition C violations. (That directionality may interfere with experimental results need not be too surprising, since backward coreference was also often rejected in control studies with adults; see, for example, Taylor-Browne 1983.)

It would therefore be useful to abstract away from directionality factors and to check

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a variable bound by a QNP, this is not a coreference problem and hence cannot possibly fall under Rule I. Furthermore, as shown by Chomsky (1982), there is no reason to assume the existence of Condition C to deal with strong crossover, since it is captured independently by other considerations. So if it turns out that children know the condition governing strong crossover, this will teach us nothing about their knowledge of Condition C.

[22] Ingram and Shaw (1981) found an intermediate result, arguing that children perform worse on (36) than on (34), but still allow coreference in (36) more than in (35).

Rule I in cases of forward coreference. Unfortunately, in a right-branching language like English, there are no cases where forward coreference is ruled out by either Condition C or Rule I—that is, cases where the antecedent is c-commanded by a pronoun to its right. The only cases that can be considered are topicalization structures such as (37a).

(37) a. *Near *Ann*, *she* saw a lion.
b. Near him$_i$, every hunter$_i$ saw a lion.

In such structures the subject can bind a pronoun in the PP, as illustrated in (37b), although it is not fully agreed how this binding is to be captured within the current theoretical framework. This entails that Rule I should block coreference in (37a), where a bound alternative exists (as should Condition C). Structures like (37a) have been amply studied, and here investigators have indeed reached a clear consensus, namely, that children guess and fail to block coreference (see, for example, Ingram and Shaw 1981, Taylor-Browne 1983, Lust, Loveland, and Kornet 1980; the exact figures vary with the experimental method). Since directionality is not a factor here, this must reflect the same difficulties we witnessed in processing the noncoreference cases of Rule I.

4 Further Critique of Grimshaw and Rosen's Account

So far we have shown that if the view of the binding theory outlined in section 2 is adopted, all relevant acquisition findings fall into place, without any need either to give up the standard expectations concerning the criteria for knowing a rule, or to stipulate any specific assumptions concerning the acquisition of anaphora. Therefore, it may appear that the issue here is a comparison between two equally successful accounts for the same acquisition facts. Next, we make such a comparison and show the factors on which the success of GR's account depends. Specifically, GR's account works only if they can explain why children perform at chance level on a rule they are presumed to know, and why this happens precisely and only in the case of coreference. In other words, it depends on whether they can show that it is purely accidental that the acquisition results come out precisely as predicted by a competing theory that they claim is wrong.

4.1

Consider once again the findings GR seek to account for:

(38)

	Construction type	*Children's performance*
a.	Condition A grammatical	good
b.	Condition A ungrammatical	good
c.	Coreference grammatical	good
d.	Coreference ungrammatical	poor
e.	Condition B grammatical (QNP)	good
f.	Condition B ungrammatical (QNP)	good

Of all the cases tested, children and aphasics performed poorly on only one, (38d). GR provide three hypotheses to explain this finding, and the contrast between this case and other experimental conditions. They suggest that the children performed poorly on the ungrammatical coreference cases because (1) they were biased to say "yes" to adult questions; (2) they may have suffered lapses of attention in some instances, and said "yes" to please the adult experimenter; and (3) the pronouns in these cases, when read emphatically, do allow coreference, in an apparent violation of Condition B. These three factors supposedly act synergistically, to bring the children's performance level to around 50% "yes" responses on a condition that should normally yield 0% "yes" responses.

Recall that GR's major theoretical claim relies crucially on the difference in children's responses to the grammatical and ungrammatical sentences used to test Conditions B and C. Yet they are left with a large remainder. Parity of argument would require the same factors to be at work in all the other experimental conditions. Specifically, differences would be expected between the grammatical and ungrammatical instances in (38a–b) and in (38e–f). Thus, GR now must explain why such differences are not found. In doing so, they invoke a different reason for each contrast: on the one hand, performance on reflexives is good in both the grammatical and ungrammatical conditions because children identify the reflexive and immediately associate it with a reflexive action. On the other hand, performance on Condition B cases with QNP antecedents is good in both grammatical and ungrammatical sentences because children cannot assign bound variable readings to pronouns. We may note that even if these claims are correct, the ad hoc nature of this account is a rather heavy price. Nevertheless, let us examine each of these claims.

4.1.1 To account for why children perform better on the bound variable cases of Condition B than its coreference cases, GR claim that children cannot assign a bound variable interpretation to pronouns and thus reject every case where such an interpretation is required. This could mean one of two things: either that children are unable to interpret quantified expressions, or that they cannot interpret pronouns as bound variables. Both are empirical claims, and there is ample evidence that goes against them. Concerning the first claim: As one of their control conditions, Chien and Wexler (1991a) tested children on constructions like "Every bear touched Goldilocks," and found their performance to be near perfect (as was the performance of aphasics tested on the same sentence types). Also, Roeper and de Villiers (1989) show that very young children (2–5 years old) can interpret sentences containing QNP. Concerning the second claim: Crain (1989) shows that young children can form questions that have only a bound variable interpretation, such as "Which two said they had a blue marble?"

A recent study (which was not available to GR) directly addresses the issue of QNP anaphora, showing that children master it. Chien and Wexler (1991b) tested children on sentences such as (39a).

(39) a. *Every Smurf* says that Adam should point to *him*.
b. Every Smurf pointed at him.

The children were nearly 100% successful in identifying anaphora as marked in (39a), just as they were with the grammatical sentences containing a referential antecedent. If GR were correct, and the reason why children got (39b) right (as a case of no-anaphora) was that they cannot interpret pronouns as bound by a QNP, then they should have gotten (39a) close to 100% wrong, rejecting the pronoun as uninterpretable. Since GR do not cite any experimental or other empirical evidence to substantiate their claim here, we must conclude that it is simply mistaken.

4.1.2 Regarding the fact that children's performance on the ungrammatical cases of Condition A is so much better than their performance on Condition B, GR argue that since Conditions A and B are different grammatical principles, there is no point in relating results concerning them to one another. This may be true, yet the question remains: if they are both grammatical principles, then the same general considerations should hold with respect to predictions about experimental results. Given that, why is it that children consistently perform well above chance on both the "grammatical" and "ungrammatical" cases of Condition A, whereas they perform differently on the two cases of Condition B—the very difference that provides GR with the main thrust of their argument?

GR suggest several explanations for this difference. One central idea is that reflexives are more salient in the text and are associated with "reflexive actions" that children see in the pictures before them. Thus, children correctly reject the "ungrammatical" case because of the mismatch between the existence of a reflexive in the sentence and the absence of a reflexive action in the picture.[23]

Note, first, that if GR are correct here, then there is no evidence that children know Condition A at all, because their successes could be attributed to their following the reflexive strategy, not Condition A. This claim is somewhat surprising (especially when it comes from those believing in the innateness of binding theory) and has direct empirical consequences regarding children's performance on other structures that fall under Condition A. We now examine these predictions.

To begin with, Condition A as currently stated covers more than just cases of "reflexive actions." For instance, no such action is involved in (40a–b), which do fall under Condition A.

(40) a. He found a picture of himself in the book.
b. He watched himself being touched by the ghost.

According to GR, such sentences (which contain reflexives, but no reflexive action) should be rejected by the children, who presumably operate on an idiosyncratic principle of equating reflexives with reflexive action that should lead them to judge grammatical all and only the cases where a sentence contains an anaphor and the situation contains some self-pointing activity. This can only mean that they have not yet learned Condition A.

[23] GR also attempt to ascribe the children's poor performance on Condition B to the lack of a discourse antecedent in the text. Yet in their experiment (as well as Chien and Wexler's (1991a)) there was such an antecedent, and performance did not improve.

The examples in (40) illustrate a prediction the strategy makes because of its dependence on the notion "reflexive action." Another prediction concerns the strategy's dependence only on equating such actions with reflexives, while ignoring all other aspects of the relationship between reflexives and their antecedents. Specifically, if all that the children who follow it do is equate reflexives with reflexive actions, then they should ignore the identity of the antecedent, even if this would lead to violations of Condition A. Consider the following experiment, which can easily decide the issue: Present the children with sentences of the standard type, namely, "This is A and this is B. Is A washing himself?" Yet in addition to the standard pictures, add a third possibility, in which B (the antecedent outside the governing category) is performing the reflexive action. The strategy proposed by GR predicts that children will accept this as a grammatical interpretation, because they "could be successful on the anaphor cases just by picking the picture of what we might call a 'reflexive action,' and not by virtue of grammatical knowledge. In this task, a subject who always selects the picture of a reflexive action when the sentence contains an anaphor will always be correct" (GR 1990: 208). So, whereas children are predicted to incorrectly reject (40), here they are predicted to incorrectly accept ungrammatical interpretations in which the antecedent to the reflexive is outside the governing category.

Grodzinsky and Kave (1990) carried out this experiment. Children were presented with pairs of sentences and pictures as in (41) and were asked to judge the match between them (using Crain and McKee's method).

(41) *Sentence*
This is A, this is B. Is A washing himself?
Pictures
a. A washing A (match)
b. A washing B (transitive mismatch)
c. B washing B (reflexive mismatch)

It turns out, as expected, that children as young as 3 have already mastered Condition A and do not rely on any strategy. They accepted the match in (41a) and rejected it more than half the time in (41b–c). Their performance levels on conditions (41a) and (41c) were significantly different, contrary to GR's prediction, and through another control it was shown that the errors they made in accepting the mismatch in (41c) had nothing to do with the binding theory.[24] Older children (5 years old)—the main age group whose performance is discussed by GR—made no errors on any conditions. Thus, the "self-pointing action" strategy, so crucial for GR's account, is false.

4.1.3 This leaves GR with one crucial claim, which should explain why children's performance on the coreference aspect of Condition B is so much poorer than in the

[24] In the control condition the children were presented with the same task, but in this case the sentences contained Hebrew reflexive verbs. These are intransitive verbs denoting reflexive actions; as such, they do not take an object, and therefore, no reflexive was present in the sentence. The results on this condition were identical to those obtained for Condition A cases, indicating that the errors observed for the "mismatch" cases had nothing to do with the binding theory but instead were related to the complexity of the task itself.

case of anaphors and QNPs. They argue that when pronouns are emphatic, they can occur in a Condition B environment. For example, (42) with a stressed pronoun is grammatical under the coreference interpretation.

(42) Mary hit HER.

Furthermore, GR claim that emphatic pronouns, unlike other coreferential pronouns, are not coindexed with their antecedent and therefore are not subject to Condition B. (They offer no further comments concerning the implications of this innovation for a theory that assumes that coreference is, crucially, captured only via coindexing.) Although we find it surprising that this fact (concerning the grammaticality of (42)) has never been noted in the extensive literature on emphatic pronouns (some of which we mention below), let us, nevertheless, follow the argument. Young children, this argument claims, master the subtleties of emphatic pronouns at this early stage of language development and know this fact. Therefore, when they hear a Condition B violation, they sometimes think the pronoun is emphatic, which explains why they allow coreference in these cases, thus reducing their performance rate to about 50%.

GR themselves point out the crucial questions this line of argument must answer: (1) Why don't children also interpret some of the cases of Condition A violations along the same lines, assuming that these contain emphatic reflexives, which would yield a similar score on Condition A and B violations? (This is even more crucial if the previous reflexive action argument does not work.) (2) Why don't children develop a strategy similar to the one GR proposed for anaphors, whereby a pronoun can never denote a reflexive action? (If this were the case, performance on Condition B violations would be much better.)

GR's answer to both questions is based on the same argument: Contexts like (42) show that it is not true that pronouns can never denote a reflexive action. In such contexts they function as reflexives, so the generalization suggested in point (2) cannot be maintained. On the other hand, the emphatic use of reflexives never changes their anaphoric status. "*Mary is pointing to HERSELF* can never mean that Mary is pointing to someone else. Thus, although emphatic pronouns *can* be interpreted like reflexives, emphatic reflexives *cannot* be interpreted like pronouns" (GR 1990:210). For this reason, emphasis does not affect children's performance on the ungrammatical sentences of Condition A.

This argument is mistaken, however. Although silent on GR's observation regarding (42), the linguistic literature is replete with discussions of reflexive anaphors violating Condition A when used emphatically. This was noted early on by Ross (1970; e.g., *Physicists like yourself are a godsend*) and Cantrall (1974) and is summarized in detail by Kuno (1987), though what precisely is meant by *emphatic* may vary both with scholars and with linguistic contexts. Zribi-Hertz (1989) collected over one hundred examples from actual English texts, two of which are given in (43).[25]

[25] GR's footnote 15 indicates that they seem to be aware of this fact, as well as of the contexts in (43). So we are not entirely certain that we have correctly followed the logic of their argument here.

(43) a. It angered him that she should have the egotism to try to attract a man like himself. (Margaret Drabble)
b. Bismarck's impulsiveness had, as so often, rebounded against himself. (Taylor)

Typically, in such cases no reflexive action is involved. The anaphor (which violates Condition A) is used here precisely like a pronoun. A much more realistic summary of the facts than that proposed by GR is that in adult grammars, although the use of pronouns as reflexives is highly marked, as in (42), the use of reflexives as pronouns is rather frequent.

Since children are presumed to know about emphatic uses, the question remains why they do not decide in some of the ungrammatical cases of Condition A that the anaphor is emphatic, yielding a 50% result, just as with the ungrammatical cases of Condition B. For example, given a typical test sentence such as (44) (from Wexler and Chien 1988), it seems that it should be at least as easy for a child, aware of emphasis, to view the anaphor as emphatically referring to Snoopy, as it is to view the pronoun as emphatically referring to the antecedent in (42).

(44) Snoopy says that Adam should give himself a car.

Needless to say, this issue does not arise if one assumes, as we have in this article, that children can compute neither the rule of coreference nor the subtleties of emphatic pronouns, but that they do know the binding theory.

4.2

A final point concerns the performance levels in the experiments we have discussed. Recall that in all the experiments (whether grammaticality judgment or sentence-to-picture matching) when subjects performed poorly, they were always around 50% correct. Why not 25% or 75% instead? Below we show that under our account, this result is expected, whereas under GR's account, it is unexplained.

Just like GR's analysis, ours relies on the apparent difference in children's performances, as measured by the percentage of correct responses on each experimental condition. Yet, unlike those (GR, Wexler and Chien) who seek to explain just these differences, we have a more ambitious goal: we purport to predict each data point in terms of its relation not just to others, but also to chance. In doing so we follow GR, who suggest that children sometimes vacillate between options. This vacillation results in guessing, or chance performance. If "vacillation" is translated into chance level performance, then the reasons underlying this level need to be spelled out. In other words, one must explain not only the contrast between "good" and "poor" performance, but also why the performance level was 50%, and not some other imaginable level that was below perfect and could be considered "poor."[26] For our account, the finding follows

[26] Since we have based our account on the findings of others, we have not been able to recover such statistics, since virtually none of the studies we have reviewed provide them. We have thus made the reasonable

naturally, given our claim that when children are unable to carry out the processing required by a rule and when given a choice of two potential antecedents, they are forced to guess. Yet for GR's account, it is not at all explicit how the actual performance level follows from the three independent factors that were discussed earlier. For the results to follow, the account should specify the exact influence of each factor (i.e., the various biases), as well as each factor's relative power when it operates together with the others—a rather difficult task, in our view. Thus, if the children's chance performance is taken to indicate a handicap, then our account is more explicit and precise than the one proposed by GR, because rather than just explain why performance is better on one construction than on another, it tells exactly why children perform in each case the way they do, independent of other constructions. It thus follows that even on such an empirical matter, our account fares better than GR's.

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assumption that (in a binary choice design) when performance is close to 50% correct, then (assuming group homogeneity) this counts as chance. When performance is 80%–90% correct, we have taken it to be above chance, and also significantly different from other performances that are at chance level.

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(Grodzinsky)
Department of Psychology
Tel Aviv University
Tel Aviv 69978
Israel

and

Aphasia Research Center 116-B
Boston VA Medical Center
150 S. Huntington Avenue
Boston, Massachusetts 02130

(Reinhart)
Department of Poetics and Comparative Literature
Tel Aviv University
Tel Aviv 69978
Israel