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Knowledge and Obedience: The Developmental Status of the Binding Theory

1. Introduction

There is a widespread view concerning the acquisition of binding, which holds that young children do not have knowledge of Principle B of the binding theory (BT) (see Lust (1986) for a review). In this article we challenge this position. We argue that the evidence merely shows that children do not reliably *obey* Principle B. It does not show that they do not *know* it. Where the evidence makes it possible to disentangle knowledge from obedience, it is possible to show that children do know Principle B, and probably obey it whenever other more pressing concerns do not interfere with their performance.

The issue of whether children have knowledge of Principle B is a central one for theoretical research into language acquisition. The overall conclusion of linguistic research into the binding theory has been that its principles are essentially universal, with room for parametric variation (for instance, in the domain of binding; see Manzini and Wexler (1987)). The most straightforward developmental interpretation is thus that children are innately endowed with the necessary knowledge and should show command of the binding theory from the beginning. A number of acquisition studies, however, have concluded that children will violate Principles B and/or C some significant percentage of the time. They have also concluded that children follow the dictates of Principle B later than they follow those of Principle A, and this has led researchers to propose that Principle B is acquired, or develops, later.

One kind of response to this puzzle maintains the standard grammatical theory and

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proposes that children do not yet apply it for some reason, perhaps because they have not figured out which expression is subject to which principle, so they bind both locally (Jakubowicz (1984), Solan (1987), Lust and Martohardjono (1987)). A second response holds that it is too simple to equate innate knowledge with early command. That is, Principles B and C may mature, along the lines suggested for A-chains by Borer and Wexler (1987). A third involves reformulating the binding theory in such a way that children can be said to conform to it from the earliest point (Chien and Wexler (1989), Varela (1989)). Chien and Wexler (1989) draw on work of Reinhart's (Reinhart (1983), Montalbetti and Wexler (1985)) in adopting the position that Principle B constrains pronouns only when they are bound variables. Under this interpretation of Principle B, they suggest, the experimental results are fully consistent with early knowledge of the binding theory.

The position we will articulate here is that despite appearances, children do in fact know the binding theory, but that failure to obey the principles mimics absence of knowledge under certain conditions. We will reexamine the critical experimental data and argue that they in fact show that children do know Principle B. We will argue that key experimental paradigms necessarily underestimate children's command of Principles B and C and overestimate their command of Principle A. Finally, we will argue that the grammatical properties of emphatic pronouns interfere with the assessment of Principle B, and we will consider an explanation for the difference between pronouns as bound variables and referential pronouns discovered by Chien and Wexler (1989). Our conclusion is, then, that children do know Principle B, and that there are some very good reasons why they do not consistently obey it in acquisition experiments.

The argument for early knowledge relies very heavily on the legitimacy of the distinction usually known as the competence/performance distinction, discussed in Chomsky (1964; 1965). Performance in an experiment, including performance on the standard linguistic task of making grammaticality judgments, cannot be equated with grammatical knowledge. To determine properties of the underlying knowledge system requires inferential reasoning, sometimes of a highly abstract sort. Needless to say, this is as true for immature subjects as for mature ones, and perhaps even more so, since the maturation and general development of immature speakers must inevitably interact with their grammatical knowledge to determine the actual outcome of any particular experiment. This line of reasoning has been developed in other research on language acquisition—see especially Hamburger and Crain (1982), Lust and Martohardjono (1987), Murasugi (1988), and Crain and Fodor (in press), where other instances of the same basic type can be found.

2. Knowing Principles B and C

The literature contains many claims to the effect that children do not know Principles B and/or C until some later stage; specific examples will be discussed below. It is remarkable, then, that production errors have not been reported, with the exception of

the use of emphatic or contrastive pronouns, discussed in section 3.4. Our view is that the experimental data rather conclusively support the position suggested by the observation of production. First, some studies, including one of our own, have found evidence that children do in fact know Principles B and C. Second, the literature that purports to show absence of knowledge actually bears on the issue of whether children obey the principles, rather than on the issue of whether they know them.

2.1. *Experimental Evidence*

A comparison of how children respond to BT-grammatical and BT-ungrammatical sentences in a grammaticality judgment task should reveal whether or not they know Principles B and C. To the hypothetical child who does not know the principles, a violation is no different from a nonviolation. Thus, a subject who does not know the principles should accept all sentences (regardless of whether they are grammatical or ungrammatical according to the adult grammar). Suppose, then, that the subject systematically treats BT-ungrammatical sentences differently from BT-grammatical ones. The only possible explanation is that the subject does in fact know the binding theory. A key feature of this comparison is that subjects do not have to be particularly successful in their treatment of BT-ungrammatical sentences—to demonstrate knowledge on their part, it is only necessary for them to treat the two classes of sentences in a systematically different way. In other words, children need not obey the binding theory, in order to demonstrate knowledge of the binding theory.

Our study is based on methods developed by Crain and McKee (1985) and used in studies like those of Chien and Wexler (1989), Kaufman (1988), McDaniel, Cairns, and Hsu (to appear), and Eisele and Lust (1989). It contrasts truth-value judgments of 4- and 5-year-old children on Principle B and C violations with their judgments on otherwise identical sentences without violations. This design allows us to compare acceptances of BT-grammatical and BT-ungrammatical sentences. The overall result is that children perform successfully on BT-grammatical sentences, but *at chance* on BT-ungrammatical sentences. Although Chien and Wexler's (1989) and Kaufman's (1988) studies both achieved generally higher results than our study, they both obtained the same response pattern, as we will show.

Since the subjects do not reliably reject BT-ungrammatical sentences, there is a sense in which they are not performing successfully with respect to binding theory violations. Yet they clearly know the binding theory, since they treat violations quite differently from nonviolations.

The test sentences discussed here fell into four basic types and included violations of Principles B and C. (The Appendix contains a description of the design and a complete list of sentence types tested.) Each BT-ungrammatical sentence was paired with a grammatical counterpart. (I) illustrates the sentence types.

- (I) a. Bert, patted him-_{ij}.
- b. He, hit Bert-_{ij}.

Table 1
Percentage judged grammatical (N = 12)

	<i>ET-grammatical</i>	<i>ET-ungrammatical</i>
Principle B	83.3	42.0
Principle C	83.3	37.5

For each sentence type in (1), the pronoun could in principle refer either to an NP inside the sentence or to a previously mentioned NP. For both types in (1), sentence-internal coreference is ungrammatical.

Each target sentence was preceded by a "context" sentence, in order to provide an antecedent for the pronoun (see section 3.1). The context sentence introduced the two participants in the scenario; the subject of the context sentence always constituted a potential antecedent for the pronoun in the target sentence. An example is: "Bert was standing next to Oscar. He hit Oscar." In total, there were 16 target sentences. The experimenters elicited truth-value judgments from the subjects using a modified version of Crain and McKee's (1985) method. (See the Appendix for a full description of the procedure.)

The children correctly accepted the grammatical sentences a high percentage of the time (83%). However, they rejected only 58% of the ungrammatical sentences for Principle B, and only 62.5% of the ungrammatical sentences for Principle C. The percentages judged grammatical appear in table 1.¹

It is clear from the percentages just given that subjects are below perfect in their performance, especially on the ungrammatical sentences; however, this by itself reveals little about subjects' knowledge of binding.

There are several reasons why subjects might perform less than perfectly on Principle B or C violations, other than because of a lack of knowledge. First, the correct response to such a violation is to reject the sentence, or say "no." However, there is a general tendency for children to answer "yes" when asked if something an adult has said is acceptable: this general response bias will tend to reduce the total number of rejection or "no" answers. Second, all the trial sentences given are grammatical under some reading. The violations of Principles B and C are only ungrammatical under the interpretation provided in the scenario. If the subjects are simply listening to the sentences, but not paying attention to the scenario on the television screen, they will tend to accept the sentences (or respond "yes"). Each of these response biases will tend to lower performance on Principles B and C, by increasing the number of false positive responses.

¹ Our figures are actually underestimates of the children's abilities: they include as incorrect responses that are clearly irrelevant to the task (such as judging all "hitting" as ungrammatical).

Because of such possible response biases the raw percentages of acceptance and rejection are not particularly informative. The key to interpreting the data is to compare positive responses to the grammatical sentences with positive responses to the ungrammatical sentences—note that this factors out the effects of the response biases just discussed. In order to do this, we compared subjects' "yes" judgments (judged grammatical) in the BT-grammatical and BT-ungrammatical conditions. If the BT-grammatical sentences are consistently treated differently from the BT-ungrammatical sentences, knowledge of binding must be influencing the subjects' responses.

The subjects performed roughly at chance on the BT-ungrammatical stimuli. It might seem tempting to conclude from this result that subjects were simply guessing, which might in turn indicate lack of knowledge. However, neither the BT-grammatical nor the BT-ungrammatical condition is meaningful on its own. The necessary comparison is between subjects' responses in the two conditions. In the BT-grammatical condition, the pronoun takes a nonlocal antecedent; in the BT-ungrammatical condition, the pronoun takes a local antecedent. If a subject does not know Principle B, then in terms of grammaticality, the local and the nonlocal antecedent are equivalent. The crucial assumption is that if there is no knowledge of Principle B, the BT-ungrammatical condition will be treated just like the BT-grammatical condition—without Principle B, both are equally grammatical. If subjects treat the two conditions differently, they are detecting a difference in the acceptability of the sentences in the two conditions, and we can reason from this that they must have knowledge of the binding theory. Thus, this crucial comparison does not require a high rate of performance on any given condition.

Table 2 displays the results of the comparison between the mean number of BT-grammatical sentences judged grammatical and the mean number of BT-ungrammatical sentences judged grammatical. The table shows the mean number of sentences (of a possible two) judged grammatical for each sentence type. The figures indicate that subjects are judging as grammatical sentences that are in fact grammatical *significantly more than those that are ungrammatical*. This is true for both Principle B and Principle C sentences.

Subjects are reasonably consistent in accepting the BT-grammatical cases—performance on BT-grammatical sentences was significantly above chance ($t = 4.69, p <$

Table 2
Mean number of sentences judged grammatical (N = 12)

	<i>BT-grammatical</i>	<i>BT-ungrammatical</i>	<i>Difference between means</i>
Principle B	1.67	.83	$t(11) = 3.08, p < .05$
Principle C	1.67	.75	$t(11) = 2.93, p < .05$

.001). However, subjects are inconsistent on the BT-ungrammatical cases—performance on BT-ungrammatical sentences was not significantly different from chance. Subjects do not reliably judge the BT-ungrammatical sentences to be ungrammatical, presumably in part because of the response biases mentioned above. Nevertheless, they do know the binding theory: they are treating violations of Principles B and C differently from sentences that are BT-grammatical.

One question that arises in our data concerns the consistency of responding across subjects. The responses to the sentences with ungrammatical readings were not significantly different from chance. The question that must be addressed is whether the mean across subjects accurately reflects the individual scores. There are two ways to get a mean across subjects that is roughly chance. One is for all, or most, of the subjects to perform at chance. This sort of result would indicate that the subjects are really vacillating in responding, just as we expect. The other way to get our result is for roughly half of the subjects to perform perfectly, responding “no” to all ungrammatical sentences, and for the other half to perform poorly, responding “yes” to all ungrammatical sentences. Such a pattern of responses might indicate (among other things) that half the subjects know Principles B and C, and the other half do not.

In order to tease apart these two potential interpretations, table 3 indicates the distribution of “yes” responses for the ungrammatical sentences. Each sentence type was presented twice, making the total possible “yes” responses 2. The figures in the first column of the table specify the number of sentences (with a maximum of 2) that subjects (incorrectly) accepted, giving “yes” responses. Thus, a 2 means that the subject was 0% correct, a 0 means that the subject was 100% correct, and a 1 means that one response was correct and one was incorrect. The figures in the second and third columns indicate the number of subjects who had a score of 0, 1, or 2. Thus, the 3 in the second column indicates that three subjects had a score of 0, meaning that they never responded incorrectly to the ungrammatical stimuli. The distribution of scores in table 3 clearly indicates that the subjects do not divide into two groups—it was not the case that one half consistently responded correctly and one half consistently responded incorrectly.

Table 3
Within-subjects frequency of “yes” responses in the ungrammatical conditions

<i>“Yes” responses</i>	<i>Principle B</i>	<i>Principle C</i>
0	3	5
1	8	5
2	1	2

Overall, the data show that subjects know reasonably well how to respond to the sentences in the BT-grammatical condition, but the data in the BT-ungrammatical condition indicate confusion or vacillation in responding; the subjects do not know what to do with the ungrammatical cases. It does not particularly matter to the core argument what analysis the subjects give to the sentences in the BT-ungrammatical condition; their differential responding in the two conditions alone indicates knowledge of Principle B.

As we mentioned above, there are other studies that contain BT-grammatical and BT-ungrammatical conditions. These include the truth-value judgment tasks of Chien and Wexler (1989) and Kaufman (1988). These studies did not compare "yes" responses in the two conditions, as in table 2, but it is clear from their raw data and calculated percentages that the same results would obtain. In addition, because in general these researchers got better results than we did on both the BT-grammatical and the BT-ungrammatical conditions, the pattern for "yes" responses emerges even more clearly.

For example, Kaufman reported her data as percent correct. If we simply convert her percentages to percent "yes" responses, then we can look directly at the differential responding to the grammatical and ungrammatical conditions. Such a transformation of Kaufman's data appears in table 4. Kaufman's study had more conditions than ours, including a condition with quantified NPs (to see whether subjects are more likely to reject Principle B violations when the pronoun is forced to have a bound variable interpretation), two age groups (2;7-3;11 and 5;0-6;5), and simple versus complex sentences. However, for our purposes, it is the BT-grammatical versus BT-ungrammatical

Table 4
Percentage judged grammatical from Kaufman (1988)

<i>Quantified NP</i>	<i>Younger</i>		<i>Older</i>	
	<i>Simple</i>	<i>Complex</i>	<i>Simple</i>	<i>Complex</i>
BT-grammatical	88	82	96	87
BT-ungrammatical	18	42	13	30
<i>Referential NP</i>	<i>Younger</i>		<i>Older</i>	
	<i>Simple</i>	<i>Complex</i>	<i>Simple</i>	<i>Complex</i>
BT-grammatical	93	88	93	88
BT-ungrammatical	23	44	10	36

comparison that is important. As the percentages show, the subjects are clearly responding differently in these two conditions across the board.²

Overall, our argument is that if the subjects do not know the binding principles, they should show identical behavior in the grammatical and the ungrammatical cases. In particular, we would expect them to accept any antecedent for the pronouns and hence to judge every sentence to be grammatical. The subjects did not do this; instead, they tended to accept the grammatical sentences, and to reject the ungrammatical sentences about half of the time. In sum, even though they did not quite know what to do about the ungrammatical ones, subjects were able to distinguish BT-grammatical from BT-ungrammatical sentences. Evidently, then, they command the principles that distinguish the grammatical from the ungrammatical. Our conclusion is that the children must know Principles B and C, even though they do not always obey them.

2.2. Other Supporting Evidence

The argument of section 2.1 supports the hypothesis that children do indeed know Principles B and C. Other studies reported in the literature, including Wexler (1988), Solan (1983), Crain and McKee (1985), and Kaufman (1987), suggest that children know the binding principles quite early in acquisition.

Kaufman (1987) has succeeded in demonstrating that children will *obey* Principle B a high percentage of the time in a truth-value judgment task, based on the methodology of Crain and McKee (1985). Kaufman found that young (even as young as 2;6 to 3) children will accept simple (unembedded) Principle B violations only 10%–23% of the time, whereas they accept nonviolations 88%–96% of the time. (The tendency to reject Principle B violations in complex sentences was somewhat lower, an effect that Kaufman attributes to the processing load associated with the additional complexity.)

² The same pattern is found in Chien and Wexler's (1989) study of Principle B violations with quantified and referential NPs. The data reported in the table below are taken from graphs and are therefore estimates of the exact percentages. Again, Chien and Wexler reported percent correct; the figures in the table are transformed to percent "yes" responses. The data show quite clearly that subjects differentiate the violations from the nonviolations.

Table 5
Percentage judged grammatical from Chien and Wexler (1988)

<i>Quantified NP</i>	<i>Age</i>			
	<4	4–5	5–6	6–7
BT-grammatical	90	90	100	100
BT-ungrammatical	55	40	15	15
<i>Referential NP</i>	<i>Age</i>			
	<4	4–5	5–6	6–7
BT-grammatical	90	90	90	95
BT-ungrammatical	70	60	54	25

McKee (1988) also argues for knowledge of Principle B on the basis of above-chance performance of Italian children on sentences involving clitic pronouns—see section 3.4 for further discussion.

Deutsch, Koster, and Koster (1986) investigated performance on Principle B using a picture selection task. Six-year-olds selected the correct picture on 53% of trials, 8-year-olds on 87%, and 10-year-olds on 90%. Deutsch, Koster, and Koster reasoned that chance was 25%, since the task (discussed in more detail below) involved selecting the correct picture from a choice of four; under this interpretation the results are far above chance, and we must conclude that their subjects know Principle B.

Chien and Wexler (1989) report an experiment in which one group of subjects rejected Principle B violations 86% of the time when the pronoun had a bound variable interpretation (as in (2)). These subjects rejected violations only 46% of the time in examples like (3).

- (2) Is every bear, washing her,?
- (3) Is Mama Bear, washing her,?

Chien and Wexler suggest that the consistent rejection of Principle B violations for the bound variable reading implicates knowledge of the principle. (In section 3.5 we take up the difference discovered by Chien and Wexler between pronouns that are bound variables and referential pronouns.)

In a set of act-out experiments on Principle C, Solan (1983) found that children allow grammatical coreference a higher percentage of the time than ungrammatical coreference. In one experiment, children were asked to act out sentences in which there was no grammatical antecedent within the sentence (Experiment 1). Solan reports that children in this experiment allowed ungrammatical coreference only 16% of the time. (Approximately 80% of the time, they assigned an extrasentential antecedent to the pronoun; the other 4% is attributable to one test sentence that allows an internal antecedent.) Solan's data clearly show that the children are treating grammatical and ungrammatical coreference differently, interpreting pronouns anaphorically a very large percentage of the time when it is grammatical to do so, but interpreting pronouns anaphorically only a small percentage of the time when it is in fact ungrammatical to do so.

McDaniel, Cairns, and Hsu (to appear) found that children's (aged 3;9–5;4) performance on an act-out task designed to test knowledge of the binding theory was almost perfect for Principle B.³ The same children did not perform perfectly on a judgment task—see section 2.3. McDaniel, Cairns, and Hsu assumed that the judgment task was a more accurate indicator of knowledge than the act-out task, primarily because of the argument made in Crain and McKee (1985).

³ For Principle C, McDaniel, Cairns, and Hsu report that 5 of their 20 subjects made at least two errors each on the six sentences designed to test Principle C. (These subjects rejected the same violations in the grammaticality judgment task.) The authors also report that adults tend to act these sentences out incorrectly as well.

Crain and McKee argue that act-out tasks using ambiguous sentences can only show us what the child's preferred interpretation is: they cannot reveal the complete set of interpretations. The logic of Crain and McKee's argument is unassailable, but it does not follow from their point that act-out data are useless. Their point is that act-out data in ambiguous situations establish preferences, and of course one possible explanation for a preference is that it is the only option allowed by the grammar. Now the case discussed by Crain and McKee concerns backward anaphora, previously thought to be disallowed by children, because in act-out tasks they habitually act out a noncoreferential interpretation. Crain and McKee argue that children merely have a preference for acting sentences out this way and that they can be shown to accept backward anaphora in a judgment task. Such a case has two critical properties: (i) there is a fairly obvious processing explanation for the preference that does not stem from the grammar, and (ii) there is no reasonable grammatical explanation for the preference.

The situation for the binding theory, though, is precisely the opposite: (i) there is a fairly obvious grammatical explanation for the preference, namely, that the children are following the binding theory, and (ii) there is no known nongrammatical explanation for their preference. Here, then, it is completely legitimate, and entirely consistent with Crain and McKee's argument, to construe the preference as mirroring grammatical knowledge. In sum, the act-out task clearly shows that children prefer to interpret sentences in a way that is consistent with the binding theory—until some alternative account is advanced, which would explain why their preferences exactly mimic the effects of knowledge of the binding theory, the results of the act-out task cannot simply be dismissed.

It is interesting to try to understand why these researchers should have found such different effects of manipulating the task. Crain and McKee's subjects performed better—that is, more like adults—on the judgment task than on the act-out task. McDaniel, Cairns, and Hsu's subjects performed better on the act-out task than on the judgment task. We suggest that the key lies in the different character of the judgments concerned. In Crain and McKee's study, success on the particular sentences at issue here involved judging a sentence with backward anaphora to be grammatical. In McDaniel, Cairns, and Hsu's study, success on these sentence types involved judging a binding theory violation to be ungrammatical. We assume that the general bias found in children toward accepting sentences rather than rejecting them (Kaufman (1987)) accounts for the differential success of the judgment tasks in the two circumstances.

The data discussed in these two sections all point to the same conclusion: children know Principles B and C. Why then do many researchers report that young children do not know the principles?

2.3. Evidence for Lack of Knowledge

Arguments that children do not command Principle B or C are based on one of two lines of reasoning. The first rests on a comparison between subjects' behavior with respect

to Principle B or C and their behavior with respect to Principle A. If subjects perform less accurately on sentences involving Principle B or C than on sentences involving Principle A, this is attributed to their not knowing Principle B or C. The second line of reasoning is that children who know the principles should perform in experiments essentially at the level of perfection—close to 100%. Since child subjects typically do not attain this level, the argument goes, they must not know the principles. We take the position that neither of these lines of reasoning is valid.⁴

Consider first the method of assessing knowledge of Principle B by comparing performance on Principle B with performance on Principle A. Research has generally found that young children perform better on anaphors than on pronouns, leading many to assume that there is a point in time when children know Principle A but do not know Principle B. The fact is, though, that children's grasp of anaphors has no bearing on the question of whether they know Principle B, the principle that regulates pronouns. Knowledge of Principle A is logically independent of knowledge of Principle B; one can either know or not know Principle B and be either better or worse at pronouns than at anaphors. So if subjects generally perform better on one or the other principle, this actually says no more about knowledge of either than if, say, they do better on tests of Subjacency or Case theory than they do on tests of Principle B. In particular, if children perform less well on pronouns than on anaphors, we cannot conclude that they lack Principle B. Although comparing anaphors and pronouns is a useful experimental technique that makes it possible to control for important variables, the Principle A/B comparison does not warrant conclusions about knowledge of either principle.

One example of the Principle A/B comparison strategy is the study by Jakubowicz (1984), in which she found performance on an act-out task to be less good for pronouns than for anaphors. From this finding, she claimed that young children apply Principle A before Principle B.

In another set of studies, Wexler and Chien (1985) and Chien and Wexler (1987) had children act out commands given by a puppet, such as those in (4), where Amy is the child's name:

- (4) a. Kitty says that Amy should point to herself.
- b. Kitty says that Amy should point to her.
- c. Kitty wants Amy to point to herself.
- d. Kitty wants Amy to point to her.

They found that for the reflexives (4a) and (4c), children do very poorly at a young age (roughly 20% correct at 2;6) and gradually get better over time (to 90% by age 6;6). In contrast, for the pronouns, children remain at about 64% to 78% accuracy from 2;6 to

⁴ Note that the grammatical/ungrammatical comparison used in the pilot study does not employ either of these strategies. It does not require 100% performance (or guessing at what level of accuracy is enough to demonstrate knowledge), nor does it require a comparison of performance on Principles B and C to performance on some independent principle of the grammar.

6;6, with no strong tendency to improve over time. They conclude that Principle A is in place before Principle B.

In effect, then, showing that children are less good at Principle B than at Principle A amounts to showing that performance on Principle B is less than perfect. It can be no more informative, since the issue of how well subjects do on Principle A has no bearing on the question of whether they know Principle B. Only performance on Principle B can be relevant to knowledge of Principle B. Thus, the usefulness of the first strategy reduces to the usefulness of the second strategy: comparing performance on Principles B and C to perfection.

Studies based on this strategy have typically found that performance on pronouns falls short of perfection. The assumption behind the strategy is that if children know the binding theory, they should never violate its principles. Of course this assumption would be correct, *if* there were no reasons other than lack of knowledge for children to violate the principles. Our view is that there are many reasons, quite unrelated to knowledge of binding, why subjects might perform below 100%. (Some of these reasons are discussed in detail in section 3.) Thus, failure to reach perfection does not tell us much about knowledge of the binding theory, since we have no clear idea of how close to perfection subjects will be if they do know the binding theory.

McDaniel, Cairns, and Hsu (to appear) found that 11 out of 20 children judged sentences with Principle B violations as grammatical. One might conclude from this that children must learn Principle B over time. However, 4 of these 11 children accepted a Principle B violation only when no alternative antecedent was available. As we will argue in section 3.1, children may violate Principle B when no alternative antecedent is provided in the discourse. Of the 7 remaining subjects who violated Principle B, 4 also violated Principle A, and 3 of these same subjects violated Principle C. Though it is certainly possible that these subjects accepted Principle B violations because they did not know Principle B, it is equally plausible that they simply responded "yes" to all grammaticality judgment questions. This leaves 3 children who clearly violated Principle B, but not Principle A or C. Does this show that these children do not know Principle B?

Finally, Solan (1983) is often cited as having data supporting children's lack of knowledge of the binding principles (specifically Principle C), because his subjects did not perform with 100% accuracy. Yet, as argued in section 2.2, and as he himself argues, his data actually strongly support the position that children in fact must know Principle C. His subjects assigned coreference within the sentence 94% of the time when the coreference was BT-grammatical, but only 16% of the time when the coreference violated Principle C.

A curious consequence of both of the two strategies for investigation of the binding theory is that conclusions based on such results conflict with any conclusions one might make based on a comparison with chance performance. For example, although the subjects in Chien and Wexler's experiments were not perfect, they do seem to know the

binding theory. Given the results on Principle B sentences (64%–78% correct), and the number of subjects (142–156), the children were clearly performing above a 50% chance level (Chien and Wexler (1987)).^{5,6}

This is the usual situation: subjects perform above chance, suggesting that they know the binding principles, yet below perfection. Subjects typically perform worse on Principle B than on Principle A, but nevertheless perform above chance on Principle B. If we require that subjects approach perfection, or match their performance on Principle A, before we will attribute full knowledge of the binding theory to them, we are left with no way to explain their above-chance performance. The tension between the two types of criteria leads Chien and Wexler (1987) to conclude that subjects have “only a little knowledge of Principle B.” Our view is that it is a mistake to equate the percentage of correct responses with the amount of knowledge commanded by subjects. Correct responses measure not knowledge but obedience.

3. Obeying Principle B

If children do know Principle B, why is it that they perform as they do? Why don't they obey the binding theory with reasonable consistency? We discuss here some reasons why children's performance on Principle B might be depressed, both below 100% and below their performance on anaphors. The reasons lie, we suggest, in the requirements imposed by pronouns and anaphors on their grammatical contexts, and the experimental consequences of these requirements.

First, the pragmatics of pronouns requires that they have an antecedent. Under certain circumstances, subjects must choose between accepting a pronoun with no antecedent in the discourse and violating the binding theory. This confounds children's

⁵ Actually, it is not totally clear what chance performance should be in these studies. For each sentence, there were three possible antecedents for the pronouns: (a) the child (ungrammatical in (4b) and (4d)), (b) the puppet (grammatical), and (c) another puppet that appeared in the context but was never mentioned (also grammatical with respect to binding). If all of the choices are in principle equally likely, the chance of choosing any given one is 33.3%. The subjects actually chose (b) 64% to 78% of the time, and (a) approximately 22% to 36% of the time. They almost never chose (c). Either the children's responses should be compared to the 33.3% chance of choosing (b), or the estimation of chance should ignore the puppet not mentioned (because apparently the children ignored it). In this case, again if the two possibilities are equally likely a priori, chance is really 50%. In either case (chance is 33.3% or chance is the more conservative 50%), it is clear that the comparison of chance to performance would come out significant.

⁶ In another study (Experiment 2), Chien and Wexler (1987) found more depressed performance on Principle B. In this study, the children's task was to give a toy to themselves or to the puppet “Kitty” in response to sentences such as those in (i).

- (i) a. Kitty says that Sarah should give herself a car.
- b. Kitty says that Sarah should give her a car.

In this task, the youngest children violated Principle B in sentences like (ib) as much as 61% to 75% of the time (violations dropped to 40% by age 6;6). However, we believe that there may have been an effect of the verb here, biasing the children's responses toward giving themselves the toy (thus violating Principle B, but obeying Principle A); Chien and Wexler even report that correct performance on the reflexive sentences (4a) and (4c) was considerably higher in this task than in the previous task (the youngest group performed at 50% rather than the 20% found for the other experiment).

grammatical knowledge of the binding theory with their assumptions about the pragmatics of pronouns.

Second, an important and influential study, that of Wexler and Chien (1985), uses possessive NPs inside subjects as alternative antecedents for the pronoun or anaphor. However, the complexity of the possessive construction itself may lead to lowered overall performance. The argument is supported by the results found in Deutsch, Koster, and Koster (1986).

Both of the design characteristics just mentioned will tend to depress performance on Principle B, since they offer the child the opportunity to make extra mistakes. The third factor is one that must tend to improve performance on Principle A. Certain picture identification tasks intended to test knowledge of the behavior of anaphors in fact allow subjects to perform correctly without using their knowledge of binding. Subjects can do the task, we argue, by noting that the stimulus sentence describes a *reflexive action*, without invoking their knowledge of the binding theory in any crucial way.

Fourth, there is a grammatical property of pronouns that must contribute to the effects obtained in experimental investigations. Emphatic pronouns are partially exempt from Principle B. Hence, if children interpret some of the presented pronouns as emphatic (or if they really *are* emphatic), the pronouns will not be subject to Principle B at all.

Fifth, one additional factor may increase performance on pronouns interpreted as bound variables relative to performance on referential pronouns. This factor is an unwillingness to assign a bound variable interpretation to pronouns, which leads to apparent high performance in sentences containing bound variable pronouns that violate Principle B.

In sum, we are suggesting that children's failure to observe Principle B in all cases, their low performance on Principle B relative to performance on Principle A, and their high performance on pronouns as bound variables need not be interpreted as direct reflections of their grammatical knowledge. The effects stem from a combination of the grammatical behavior of pronouns and extragrammatical factors of various kinds.

3.1. *Pronouns and Antecedents*

The first point is that (used noncontrastively and nondeictically) third person pronouns are extremely unnatural without a linguistic antecedent. The following discourses illustrate this: all cases in (5), where there is no antecedent for the pronoun, are extremely odd when compared to those in (6), where there is an antecedent.

- (5) a. Bill saw *him*.
- b. Mary thinks Bill saw *him*.
- c. Mary came in at 6. *He* saw her.
- (6) a. *John* said that Mary came in at 6. *He* saw her.
- b. According to *John*, Mary came in at 6. *He* saw her.

Note that the examples in (5) are not improved (again with a nondeictic and noncontrastive pronoun) if those involved in the discourse are looking at a picture of some male who could plausibly be taken to be "him." What is required is a *linguistic* discourse antecedent, and that is not provided.

In fact, it is not even enough to mention the antecedent; it seems that the antecedent has to be prominent in the discourse, perhaps a kind of topic:

- (7) a. *John and Mary* went swimming. She dived in.
- b. *John* went swimming with Mary. She dived in.
- c. *Mary* went swimming with John. She dived in.

Only (7c) sounds completely natural with *she* construed strictly as noncontrastive and hence unstressed. Both (7a) and (7b) require stress on the pronoun.

Now, suppose a child knows the binding theory and therefore knows that the antecedent for a pronoun cannot be "too close" to the pronoun. The child also (correctly) believes that pronouns normally have discourse antecedents. What happens if a child is presented with sentences like (8)? The only potential antecedent for the pronoun in (8) is one that is too close to it.

- (8) The Smurf is talking to him.

In this situation one or the other of the child's two principles must be violated. Either the child must construe *him* and *the Smurf* as coindexed, violating Principle B, or the child must assign no discourse antecedent for *him*. The grammatically incorrect construal here violates Principle B but respects the pragmatics of pronouns. A child who violates Principle B here would be making sense of the sentence, even if doing so requires taking an improper antecedent. The grammatically correct construal, on the other hand, violates the pragmatic requirements of third person pronouns. Subjects must choose between assigning the pronoun an unmentioned and thus pragmatically illegitimate antecedent and assigning it a grammatically illegitimate antecedent.

What will a child do in this situation? Of course, no theory predicts in any strong sense what will happen, since we have no principled weighting of the two options. A reasonable expectation is that the child will vacillate between one violation and the other, violating Principle B some of the time, and the antecedent requirement for pronouns some of the time. If this reasoning is right, then chance performance on such sentences does not necessarily show that children do not know Principle B, because there is a reason why we might find chance performance on such sentences, even if children *do* know the binding theory. Any experiment that uses sentences like those in (8) sets up a perfect confound between the two factors, because there is no alternative antecedent for the pronoun. We cannot tell whether any observed performance stems from (lack of) knowledge of the binding theory or from respect for the pragmatics of pronouns.

If pronouns must have discourse antecedents, why do adults nevertheless judge sentences with no linguistic antecedent for the pronoun as well-formed? Also, why do

adults perform better than children on these tasks, even where no alternative antecedent is provided? There are a number of possibilities: (a) adults are able to factor out the pragmatic oddness; and/or (b) adults reinterpret the pronoun as contrastive; and/or (c) adults internally construct an additional context in which the appropriate antecedent is available, by imagining a previous sentence (such as "John described what happened") that would render the use of a pronoun sensible. In this view, adults judge sentences lacking discourse antecedents for pronouns as grammatical, and perform at a high level in the experimental situations, because they bring nonlinguistic capacities to bear on the problem. Children may be unable to perform the additional computations required to construct a sensible interpretation of a sentence containing an antecedentless pronoun. The difference between adults and children does not necessarily reside in their knowledge of the binding theory.

A number of findings in the literature support the view that children seek to assign discourse antecedents for pronouns.⁷ A very simple one is that children very rarely take an entity unmentioned in the experimental stimulus to be the antecedent for a pronoun. For example, Sigurjonsdottir, Hyams, and Chien (1988) conducted a study of the interpretation of reflexives and pronouns by Icelandic children, tracking the percentage of items where a pronoun or reflexive was taken to refer to an individual not mentioned in the test item. It hovered around 5%.⁸ Similarly, Wexler and Chien (1985) report that there were very few cases where subjects selected a puppet that had not been mentioned in the discourse, under 5% for children over 3, judging from the graphs provided. This result supports our general line of reasoning, because it shows that children do not pull antecedents for pronouns out of thin air, but seek them inside the discourse.

An interesting point to note is that (in both Wexler and Chien's study and in Sigurjonsdottir, Hyams, and Chien's study) the figures were roughly comparable for the long-distance anaphor and the pronoun. In terms of the binding theory a pronoun and an anaphor are crucially distinguished in that the anaphor must have an antecedent (potentially a long-distance antecedent in Icelandic), and the pronoun need not. However, the children treated them in approximately the same way, which is exactly what we would expect if the pronoun is subject to a discourse antecedent requirement: both pronouns and anaphors require antecedents, although for different reasons.

Another relevant finding is reported by McDaniel, Cairns, and Hsu (to appear). As previously mentioned, 11 of their 20 subjects showed at least one Principle B violation.

⁷ If children are indeed seeking antecedents for pronouns, we might expect to be able to manipulate their performance on Principle B by using an antecedent to bias the interpretation of the pronoun, either toward BT-grammaticality or toward BT-ungrammaticality. Lust, Loveland, and Kornet (1980), Solan (1987), and Stevenson and Pickering (1987) have explored this in various ways. In general, all three experiments found that the linguistic context can influence the subjects' tendency to assign coreference between a pronoun and a sentence-internal antecedent.

⁸ Nina Hyams has informed us that even adult subjects in the study chose a sentence-internal antecedent in the Icelandic counterpart of sentences like *John_i told Bill to shave him_i*. This binding relation is generally judged as ungrammatical, yet speakers preferred this interpretation to one in which the pronoun had no antecedent.

Four of the 11 subjects who violated Principle B disallowed coreference within the subordinate clause in (9a) and (9b) but allowed it in (9c).

- (9) a. Grover thinks that Cookie Monster is touching him.
- b. Cookie Monster wants Grover to wash him.
- c. Grover is washing him.

They note this as a puzzle: the result appears to be the opposite of that predicted by general reasoning. For example, (9c) is surely simpler than (9a) or (9b); hence, subjects should perform better on (9c). (Indeed, Kaufman (1987) did find that in general children's success rate on the complex sentences was lower than on simpler sentences, just as we would expect.) So why should these children be least successful on the simplest example? Under the present hypothesis, we predict exactly this result. Since there is a binding-theoretically legitimate linguistic antecedent for the pronoun in (9a,b), there is no reason for subjects to violate Principle B. Hence, a child who is behaving as expected would be able to assign an antecedent to the pronoun in (9a,b) without violating the binding theory. However, there is no alternative antecedent in (9c), so the child must violate either Principle B or the discourse antecedent requirement. Evidently this particular group of subjects assigned the pronoun an antecedent at the cost of violating Principle B.

It is apparent that in certain tasks, subjects will tend not to choose an unmentioned object as the antecedent for pronouns, even violating the binding theory in preference to assigning an unmentioned object as antecedent. However, in act-out tasks subjects seem to assign an unmentioned object as the antecedent when faced with no other BT-legitimate choice. For example, Solan (1983, Experiment 1) found that when there was no BT-legitimate antecedent in the sentence, subjects looked outside the sentence for an (unmentioned) antecedent 80% of the time. This suggests that subjects are relatively willing to assign unmentioned reference in act-out tasks, even though they are reluctant to assign unmentioned antecedents in grammaticality judgment tasks. Even in act-out tasks, though, children do seem to *prefer* to choose the (mentioned) internal NP for the referent of the pronoun. For example, Solan (Experiment 4) also found that subjects assigned an internal antecedent to the pronouns 94% of the time when it was BT-legitimate to do so, choosing an unmentioned object only 6% of the time.

Apparently, what subjects do, when faced with a conflict between the antecedent requirement and the grammar, may depend on the task itself. In an act-out task, the child is given the sentence and asked to construct, by acting out, the context for the sentence. In so doing, the subject may be able to internally introduce the proper antecedent for the pronoun.

To sum up, children's performance in various experiments bears out the hypothesis that they expect pronouns to have discourse antecedents. This in turn supports the view that where there is no legitimate antecedent for a pronoun, children may violate the binding theory in order to provide one.

3.2. *The Interpretation of Possessives*

A rather different paradigm is employed in a set of studies by Wexler and Chien (1985) and by Deutsch, Koster, and Koster (1986). They presented children with sentences like (10a,b):⁹

- (10) a. Cinderella's *sister* pointed to *her*.
 b. Cinderella's *sister* pointed to *herself*.

Such examples do introduce two potential antecedents for the pronoun or anaphor and hence avoid the problem discussed in section 3.1. This paradigm provides a grammatically and pragmatically legitimate antecedent for the pronoun—namely, the possessor. The containing NP, on the other hand, headed by *sister*, is too close to the pronoun and hence not a grammatically possible antecedent.

In the study described in Wexler and Chien (1985), subjects were presented with a sentence and a pair of pictures and had to select the picture that matched the sentence. Wexler and Chien report that on the pronoun sentences, children performed at close to chance level until they were around 5;6. That is to say, given (10a), they were about equally likely to select the picture of the sister pointing to the sister, as the picture of the sister pointing to Cinderella.

Why should children's performance on the two-picture study be so poor? The key seems to be their understanding or treatment of the possessive. One possibility is that their choosing the sister as the antecedent, rather than the possessive, reflects a response bias. This could be assessed using controls that contain the same potential antecedents, but where either antecedent is legitimate with respect to Principle B:

- (11) Cinderella's sister said that the prince pointed to her.

In (11) either Cinderella or the sister can act as an antecedent for *her*; hence, the number of times that subjects pick the sister (rather than Cinderella) as the antecedent would give us a baseline for the choice between a possessive and the higher NP as antecedent. Now we can measure any effects of Principle B by comparing the number of times the higher NP is chosen in examples like (11), where it is compatible with the binding theory, and the number of times the higher NP is chosen in examples like (10a), where it is not compatible with the binding theory.

Suppose, for example, that subjects chose the higher NP in 90% of cases for (11) and in only 50% of cases for (10a). Even though performance on (10a) itself would appear to be at chance, as it did in Wexler and Chien's study, comparison of the two would tell us that Principle B is at work. Thus, it is quite possible that the kind of reasoning employed in section 2 would be relevant here also—even chance performance does not necessarily implicate absence of knowledge.

Though there is, as far as we know, no currently available evidence bearing on the

⁹ Wexler and Chien (1985) in fact report three experiments. The third is discussed in section 2.3. The second proved hard to interpret because it used a problematic NP structure: *the sister of Cinderella*.

particular point just raised, there is strong evidence concerning the interference of possessive NP structure in the interpretation of stimulus sentences like those in (10). The reasoning behind Wexler and Chien's experiment is that we can tell from the picture they choose whether subjects know the difference between antecedents for pronouns and antecedents for anaphors. A subject who consistently selects the right pictures when given a pronoun sentence knows that the antecedent must be nonlocal or non-c-commanding and hence knows that the antecedent cannot be the subject NP itself, since it is a local c-commander. This argument depends on subjects' having adequate command over the structure of the possessive and thus assigning the right structure to the subject NP. If children misinterpret the possessive and construe the possessor rather than the head as the subject of the sentence, then this may well lead to apparent cases of failure to obey the binding theory.

In the two-picture study, there is no way to tell whether children have taken the wrong NP as subject or not, since they choose between two pictures, each of which shows the *same* (correct) subject.¹⁰ However, Deutsch, Koster, and Koster (1986), in a similar study of pronouns and anaphors in Dutch children between 6 and 10 years old, offered subjects a choice among *four* pictures. Two of them had the wrong subject—that is, pictured the referent of the possessive NP as the actor, rather than the referent of the containing NP. For the sentence in (12), for example, subjects chose among the four scenarios indicated in (13a–d).

(12) Piet_p's brother_b ties him_{p/b} up.

- (13) a. b ties p up
 b. b ties b up
 c. p ties b up
 d. p ties p up

Picture (13a) shows the correct interpretation of the sentence. Picture (13b) shows the correct subject but the wrong analysis of the pronoun. Pictures (13c) and (13d) both show the wrong choice of subject—Piet instead of the brother. Choosing picture (13c) in which Piet ties up the brother counted as an error on subject choice only, since the pronoun was correctly construed relative to the choice of subject. Choosing the picture (13d) in which Piet ties Piet up counted as an error on both, since the subject is analyzed incorrectly and the pronoun is not properly treated with respect to the child's choice of subject. (Note that pictures (13a) and (13b) correspond to those that Chien and Wexler presented their subjects with.)

Deutsch, Koster, and Koster's investigation revealed that the misanalysis of the subject (which they called the "antecedent error") was the most common error of all,

¹⁰ Wexler and Chien (1985: 142) argue that their subjects did understand the possessive, on the grounds that performance was constant across verbs. This is a valid response to the hypothesis that children are just using the semantics and pragmatics of individual verbs to guess at an answer. As far as we can see, however, it does not bear on the validity of the hypothesis that children use their own incorrect analysis of the subject NP as the basis for interpreting pronouns and anaphors.

especially for subjects of the form *NP's N* (they also tested prepositional possessives). When their data were broken down by pronoun versus anaphor, the data for 6-year-olds showed that fully 30% of their responses to pronoun sentences involved antecedent errors, whereas only 11% involved errors in the interpretation of the pronoun. An additional 5% of responses were analyzed as showing both types of error, as in (13d). In other words, subjects made twice as many errors on the analysis of the subject as they made on the treatment of the pronoun, and they performed far above chance with respect to Principle B.

What should we make of all this? The analysis conducted by Deutsch, Koster, and Koster clearly shows that their subjects made many more errors on the subject NP than they made on the anaphor or pronoun itself. But this motivates a reinterpretation of data from Wexler and Chien's (1985) two-picture study, which does not separate out the effects of the possessive subject from the effects of the binding theory, at least not in any direct way. If children interpret the subject NP one way when they hear the sentence, but then have to choose between two pictures that reflect the other interpretation of the subject NP, we do not know how they will behave. In particular, we do not know whether their response to this situation (one that arose more than 30% of the time for 6-year-olds in Deutsch, Koster, and Koster's study) will mimic lack of knowledge of the binding theory.^{11,12}

Note moreover that in the four-picture study we can examine the children's performance on the pronoun and anaphor *relative to their own choice of subject*. In a recent paper clarifying the interpretation of Deutsch, Koster, and Koster's data, Koster (1988) argues that even though the majority of errors on the pronoun sentences were errors in the subject and not in the pronoun itself, these still indicate errors on Principle B, in particular errors in the c-command relation. Under Koster's interpretation of errors like (13c), they involve two independent mistakes: the subjects are assigning coreference between a pronoun and a c-commanding antecedent, which violates Principle B, and they are also assigning the wrong NP the role of Agent.

The interpretation we take here, however, is that (13c) errors stem from a misanalysis of the possessive, in which the child analyzes the possessive NP as the head of the subject, and the binding theory then applies correctly. The logic of the situation is such that once a child has misanalyzed the subject NP, the binding-theoretic possibilities

¹¹ Wexler and Chien (1985) found a clear difference between performance on Principle B (which remained relatively stable) and performance on Principle A (which improved fairly rapidly). This pattern might seem to argue against the idea that it is the analysis of the subject that is problematic, since this problem should be constant across pronouns and anaphors. However, we will show later that there may be independent reasons for subjects' higher performance on Principle A.

¹² One further point: the age of subjects is quite different in the two studies. Since Chien and Wexler's subjects were aged 2;6-6;6, and Deutsch, Koster, and Koster's subjects were aged 6-10, it might be possible to argue that the younger group of subjects did not have a good grasp of Principle B, but the older group of subjects had improved to the point where they basically followed it. However, this seems a dangerous conclusion, given that the younger subjects are surely likely to have been even more susceptible to the subject error on possessives than the much older subjects of Deutsch, Koster, and Koster. Any discounting of results, then, must apply in even stronger terms to the younger subjects.

for the pronoun and the anaphor are reversed. Consider (12) again. Suppose the child construes *Piet* as the subject (presumably giving some other grammatical analysis to the head). If *p* is the subject NP, it c-commands the pronoun; hence, it is not a possible antecedent for the pronoun, under this grammatical analysis of the subject. *b*, however, should be a legitimate antecedent, since it is not the subject and hence does not c-command the pronoun. So the grammatical analysis in which the possessor is construed as the subject automatically reverses the set of possible anaphoric relations. When children misanalyze the subject, there are two ways in which they could obey the binding theory: they could compute the anaphoric possibilities either on the referent of the original subject, or on their own assigned subject, which is what we assume. On our view, then, only errors of type (13b) and (13d), not (13c), are binding theory errors. Of course, this method of scoring is not available in the two-picture study, since there is no way to determine the child's choice. What this means, though, is that responses that we would construe as obeying Principle B in Deutsch, Koster, and Koster's experiment might well have been scored as incorrect in the two-picture study, since relative to the *original subject* the responses would indeed be incorrect ones.

In sum, subjects' low performance on the picture selection task for sentences like (12) seems to reflect in large measure problems with the possessive subject, rather than lack of knowledge of the binding theory. If errors of possessive analysis are factored out, it seems likely that children in both experiments are obeying Principle B a high percentage of the time.

3.3. *Reflexive Actions and Reflexive Anaphors*

One result that has emerged rather consistently in experimentation is that performance on anaphors generally seems to be much stronger than performance on pronouns (Jakubowicz (1984), Deutsch, Koster, and Koster (1986), Wexler and Chien (1985), Chien and Wexler (1987), McDaniel, Cairns, and Hsu (to appear), Solan (1987)). Early observance is expected for Principle A, which is generally assumed to be in place all along, and detectable as soon as children have identified anaphors (Otsu (1981)). But if Principle B is also available from the very beginning, why has the asymmetry been so pervasive?

The difference will be explained if there are factors that lower children's performance in tasks designed to test Principle B or that raise children's performance in tasks designed to test Principle A. One of these was discussed in section 3.1: the absence of antecedents for pronouns can induce results that violate Principle B. We turn now to the other side of the coin.

In the experiment we have already discussed, reported by Wexler and Chien (1985), subjects were given sentences like those in (14):

- (14) a. Cinderella's sister pointed to herself.
- b. Cinderella's sister pointed to her.

Their task was to select the picture that matched the sentence. For (14), they had to choose between a picture in which the sister pointed to the sister (the correct response

for (14a)) and a picture in which the sister pointed to Cinderella (the correct response for (14b)). The idea is that if they know the binding theory, they will know that (14b) cannot mean that the sister pointed to the sister, and that (14a) cannot mean that the sister pointed to Cinderella.

This task, and the similar one used by Deutsch, Koster, and Koster (1986), offers the subjects a chance to use a nongrammatical strategy—there is another way of doing this task that does not implicate the binding theory at all. Subjects had to choose between a picture in which someone is doing something to him/herself and a picture in which someone is doing something to someone else. Thus, a subject 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.¹³ In this task, a subject who always selects the picture of a reflexive action when the sentence contains an anaphor will always be correct. The subject need only recognize that the sentence names an action of self-pointing, or self-seeing, and then pick the picture to match.

Setting aside the possible effects of the subject error discussed in section 3.2, the reflexive action strategy would give perfect performance on anaphors in Chien and Wexler’s experiment, once subjects have analyzed *self* correctly. In Deutsch, Koster, and Koster’s experiment this strategy would give perfect performance with respect to the anaphor/pronoun error, leaving children only with the potential to make errors on the analysis of the subject NP.

The point is that this strategy does not depend on knowledge of the binding theory—it can be used with equal effectiveness in the absence of any antecedent-anaphor relationship at all. It is possible to get the answer right even if the subject is truncated altogether, giving partial sentences like *points to herself*. Thus, performance on the test does not necessarily require a grammatical relationship of anaphora.¹⁴ If this is correct, subjects can get the right answer either by using their grammatical knowledge of Principle A or by using the reflexive action strategy. Thus, the higher percentage of correct responses on Principle A violations is entirely consistent with the view that subjects know both principles and have an additional way to get the right answer for anaphors.

The general trend in studies by Chien and Wexler and by Deutsch, Koster, and Koster shows performance on Principle A improving rather rapidly while performance on Principle B remains relatively constant, above chance but not stellar. The authors draw various conclusions from this result, but the analysis of the picture selection task introduces another possible explanation: the rapid development in performance on Principle A may simply reflect increasing use of the strategy of choosing reflexive action pictures.

¹³ It would be worth investigating whether subjects use the reflexive action strategy in languages with long-distance anaphors, where it will not always be successful.

¹⁴ Another possible factor is the choice of verbs in these experiments. Verbs like *wash*, *dress*, *scratch* are commonly employed in stimuli, but they all belong to the class of verbs for which there is an intransitive use with a reflexive interpretation: *She dressed/washed/scratched*. Thus, if subjects treat the object as if it were not there, they might well construct a reflexive reading.

The general point is, then, that the asymmetry in performance on Principles A and B may reflect the combination of experimentally depressed performance on Principle B and inflated performance on Principle A. The effects could very well resemble the effects we would find if in fact Principle B developed later than Principle A.

3.4. *Emphatic Pronouns and the Principle A/B Asymmetry*

Researchers sometimes report that children violate Principles B and C in the experimental situation, actually producing sentences like (15):

(15) Mary hit Mary/her.

This apparently odd phenomenon follows, we believe, from the emphatic character of the lexical NP or pronoun. Sequences like (15) are uttered during an attempt to explain something very clearly to the experimenter, often to contradict or amplify another utterance (see Kaufman (1987; 1988) for some related discussion). Hence, the pronoun or lexical NP is typically emphatic and heavily stressed. It seems that under these conditions, pronouns are not fully subject to Principle B. The expectation is, then, that Principle B and C violations in production will be limited to emphatic contexts. Children, like adults, may very well say *Mary hit HER*. Also like adults, however, they should not say *Mary HIT her*, with coreference intended. The fact that reported production data do not seem to contain such errors strongly supports the position that children know Principle B.

The fact that stressed/emphatic pronouns are at least partially exempt from Principle B may also contribute to the reported asymmetry between the developmental status of Principle B and that of Principle A. Examples like (16) are acceptable even if *I* and *he* are construed as coreferential with the pronouns.

- (16) a. Unfortunately, when I look into the mirror I don't see you, I see *ME*.
 b. When he looks in the mirror he doesn't see me, he sees *HIM*.

If *me* and *him* are not emphatic—if they are unstressed, for example—the sentences are of course ungrammatical with coreference, because they constitute Principle B violations. But the violations disappear, or are at least greatly muted, when the pronouns are emphatic and heavily stressed, so that an emphatic pronoun can be construed as coreferential with a local c-commanding NP, even though this is generally a property of anaphors only. This effect seems to depend in part on the pronoun involved—for most speakers it is much clearer for first and second persons than for third person, and most strongly felt in the “mirror” context of (16).

We assume that emphatic pronouns are not subject to Principle B because they are not *bound* to the c-commanding NP. They are coreferential with their antecedent, but not grammatically coindexed with it. Hence, Principle B simply does not apply to them. A similar point holds for Principle C: sentences like *The dog hit THE DOG*, *John likes only JOHN* are grammatical when the lexical NP is emphatic or contrastive, even though the NP has a local coreferential c-commander.

So emphatic pronouns can violate or circumvent Principle B. However, the behavior of emphatic reflexives does not match that of the pronouns. An emphatic reflexive can *never* be interpreted like a pronoun, as lacking an antecedent altogether.¹⁵ Whereas *Mary is pointing to HER* can in certain contexts mean that Mary is pointing to Mary, *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.

This asymmetry between the behavior of (emphatic) pronouns and the behavior of reflexives may contribute significantly to the developmental facts. If children sometimes treat pronouns (and also reflexives) as emphatic, or if experimenters present children with emphatics, the pronouns will not be subject to the binding theory anyway. In addition, the emphasis factor may play a role in the strategy suggested in section 3.3. Recall that the argument is that subjects can select the correct picture for a reflexive sentence purely by deciding that the sentence describes a reflexive action and then choosing a reflexive action picture. The question is, Why wouldn't a similar strategy work for pronouns? Why couldn't a subject select a nonreflexive action after hearing a stimulus sentence containing a pronoun? The answer is that, as we have just noted, pronouns are not restricted in their interpretation to nonreflexive circumstances.¹⁶ Since a pronoun *can* be used in the description of a reflexive action, no strategy comparable to the one for reflexives could be effective for pronouns.

As a second piece of evidence, note that the properties of emphatic pronouns will contribute to explaining the general depression of performance on Principle B relative to Principle A, already discussed in section 3.3. Pronouns are not always subject to Principle B, but anaphors are always subject to (the core part of) Principle A. Thus, performance on sentences related to Principle A will not be affected by the emphatic or nonemphatic quality of the anaphor (except with respect to the locality of the binding relation; see footnote 15). Performance on Principle B, on the other hand, will be strongly affected, since emphatic pronouns will be accepted even in circumstances that violate Principle B. Hence, any effect of the emphatic/nonemphatic problem will inevitably lower apparent performance on Principle B, while leaving performance on Principle A unaffected (again, modulo locality). Unlike the issue of reflexive actions raised in section 3.2, the exemption of emphatic pronouns potentially affects performance on tasks other than picture identification. Hence, the behavior of emphatics may very well have contributed to results like those of Wexler and Chien (1985) and Chien and Wexler (1987).

The hypothesis that the grammar of emphatic pronouns is in part responsible for

¹⁵ Although emphatic reflexives do differ from nonemphatics in certain respects—for instance, their antecedent may be nonlocal. So an example like (i) is grammatical when the reflexive is emphatic:

(i) Susan believes that the audience should applaud only **HERSELF**.

¹⁶ The ambiguity of pronouns in sentences like *Jack pulled the blanket around him* may also contribute here, as well as adding to the general complexity of interpreting pronouns, as Solan (1987) notes. It must be admitted, though, that these factors may explain why a non-reflexive-action strategy would not work, but they do not necessarily explain why subjects do not use one.

Principle B violations makes a clear prediction with respect to clitic pronouns in the Romance languages. Since they cannot be contrastive, or emphatic in any way, they will never be exempt from the effects of Principle B. Children learning French, Italian, or Spanish should therefore obey Principle B more systematically than children learning English, other things being equal. Solan (1987) reports a study by Solan and Ortiz (1982) of (bilingual) Spanish-speaking children, in which subjects showed a higher success rate for Principle B (tested by sentences like (17a)) than for Principle A (tested by sentences like (17b))—the opposite of the usual finding for English.¹⁷

- (17) a. Juan dijo que Pedro lo golpeó.
 Juan said that Pedro him hit
 'Juan said that Pedro hit him.'
- b. Juan dijo que Pedro se golpeó.
 Juan said that Pedro himself hit
 'Juan said that Pedro hit himself.'

Solan suggests that this is because the grammar of reflexive clitics is highly complex, lowering success on Principle A relative to English. The effect would follow equally from the unambiguous status of clitic pronouns in Spanish. They are systematically subject to Principle B, since they can never be emphatic.

Although a comparison of responses to clitic pronouns and direct object pronouns *in situ* has not been done, Rivera (1985) compared young children's responses to direct object clitic pronouns and (*in situ*) pronouns as objects of prepositions on an act-out task. He found generally that his subjects were able to distinguish pronominal from reflexive uses earlier for the object clitic pronouns than for the prepositional pronouns. Of course, in Rivera's comparison, the entire syntactic construction was varied across the conditions, not just the clitic/nonclitic nature of the pronominal.

McKee (1988) reports that Italian-speaking children aged 3;1–5;5 reject Principle B violations involving clitic pronouns on 80%–85% of trials, or in the 90% range if the responses of five children who seem to have a strong "yes" bias are factored out. As McKee (1989) argues, the result for clitic pronouns is much higher than results obtained in comparable studies for English. This suggests both that children do indeed know Principle B and that the clitic/nonclitic distinction has the expected consequences.

To sum up, we are arguing that children's behavior with respect to Principle B is in part a function of the grammatical properties of emphatic pronouns. Since emphatic pronouns do not obey the binding theory, interference from them will lower obedience to the binding theory. A number of specific results fall into place under this assumption: they include the asymmetry between pronouns and anaphors, the behavior of clitic pronouns, and the characteristics of Principle B violations in production.

¹⁷ The absolute figures are of course not directly interpretable for our purposes, since the Romance constructions may not be comparable in complexity to English nonclitic constructions.

3.5. *Pronouns as Bound Variables*

An argument with the same logic as the Principle A/Principle B comparison has been made in comparing performance on referential pronouns to performance on pronouns that are interpreted as bound variables. Chien and Wexler (1988; 1989; Wexler and Chien (1988)) compared children's performance on Principle B for pronouns as bound variables with their performance for pronouns with referential antecedents, contrasting pairs like those in (18):

- (18) a. Is Mama Bear washing her?
 b. Is every bear washing her?

The children's task was to decide whether a sentence like (18a) or (18b) was a true description of a picture they were presented with, so this study uses a truth-value judgment task of a particular kind.

Chien and Wexler discovered that children gave more correct responses on sentences that violated Principle B when the pronoun responsible for the violation was a bound variable than when it was not. (At least this was the general trend; the difference emerged most clearly for the 5- to 6-year-old age group.) Thus, children rejected examples like (18b) as descriptions of reflexive activities more reliably than examples like (18a). This result has not been replicated in acquisition studies, although current research reported in Grodzinsky, Wexler, Chien, and Marakovitz (1989) does replicate the finding for agrammatic aphasics. Kaufman (1988) and Lombardi and Sarma (1989) found no difference between bound variables and other pronouns. No study seems to have found the opposite result, however, and in our discussion here we take Chien and Wexler's finding to indicate a real difference between the two kinds of pronouns.

Chien and Wexler suggest that this distribution of judgments is explicable under a version of the binding theory in which Principle B regulates pronouns acting as bound variables, but not referential pronouns. According to this interpretation of the data, children correctly reject Principle B violations with bound variables because these are under the jurisdiction of the binding theory, whereas for referential pronouns the binding theory does not determine coindexing possibilities. Hence, we should attribute to them knowledge of the binding theory in a particular form, namely, one in which referential pronouns are not subject to Principle B. A version of the binding theory along these lines has been developed by Reinhart (1983; 1986) and by Montalbetti and Wexler (1985).

Fundamentally, then, the argument is that children are better at bound variables than at referential pronouns because they know the binding theory, and it constrains bound variables and not referential pronouns. It should be noted that Chien and Wexler's proposal attributes full knowledge of the adult binding theory to the child, and in this major respect their interpretation of the binding theory data is the same as ours. The residual issue lies in what the adult binding theory is considered to look like (see Reinhart (1983; 1986), Higginbotham (1983), Burzio (1989), Kaufman (1988), and Lasnik (1989) for discussion).

A number of considerations seem to support the standard version of the binding theory. The major issue concerns the status of the principle(s) responsible for explaining judgments of locally bound pronouns that are not bound variables. If they are not subject to the binding theory, what rules out sentences like (19a) with coreference between the two NPs given a nonbound variable interpretation? The answer must be that some other (probably pragmatic) principle rules out such sentences (see especially Montalbetti and Wexler (1985) and Reinhart (1986)), on the grounds that there is an alternative sentence with the same meaning (19b).

- (19) a. He hit him.
b. He hit himself.

Cases like those in (20) then pose problems for such an account, since either the pronoun or the anaphor can occur in these examples, and if here, why not in (19)?

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

In a similar vein, N. Chomsky points out (personal communication) that a pragmatic principle seems to make the wrong prediction for the interpretation of examples like (21):¹⁸

- (21) Many students expect them to leave.

Since the reflexive version (22a) has only the reading involving quantification over individuals, (21) should have a collective reading for the pronoun, just as (22b) does.

- (22) a. Many students expect themselves to leave.
b. Many students expect that they will leave.

Yet (21) is in fact unambiguous, just as the standard binding theory predicts.

There is also a more general theoretical question concerning the relationship between the distributions of the two kinds of pronouns. If they are not subject to the same principles, then any similarity between them is accidental. Thus, the fact that the pronoun-antecedent relationship in both cases is subject to the same nonlocality requirements in English cannot be explained. (Interestingly, the binding domains are not identical in Chinese (Aoun and Hornstein (1986)); nevertheless, the difference can be simply expressed in terms of a distinction between A-binding and \bar{A} -binding of the pronouns.)

These considerations point toward the conclusion that Principle B does constrain pronouns even when they are not bound variables. But then how can we explain Chien and Wexler's data? A striking property of their experimental finding is that it contradicts the commonsense expectation: since the bound variable reading seems considerably

¹⁸ A similar argument is made in Lasnik (1989), on the basis of the interpretation of possessive pronouns in VP ellipsis.

more complicated than the referential reading, it is surprising that children manipulate it more easily. We suggest here another interpretation that rests on the idea that children are *worse* at bound variables than at regular pronouns, not better.

When presented with a picture that does not match the interpretation they have constructed for a stimulus sentence, subjects will reject the picture-sentence pair. Suppose that children find the distributed reading associated with the quantifier-bound variable pair difficult, and construct this interpretation for pronouns less often than the alternative interpretations. This will lead subjects to reject sentence-picture pairs involving the bound variable interpretation more *overall* than pairs involving the other interpretation. Hence, we will find a difference between subjects' rejection rate for bound variables violating Principle B and referential pronouns violating Principle B, just because of a baseline difference between the two readings for pronouns.

In order to evaluate this proposal, we must investigate pronouns that do not violate Principle B, to distinguish between the effects of a Principle B violation and the effects of a bound variable interpretation. A comparison of children's interpretations of (23a) and (23b), and (23c) and (23d), would provide a baseline measure of their relative preferences for bound variable and referential readings.

- (23) a. *The boy* told Sam that Mary kissed him.
 b. *Every boy* told Sam that Mary kissed him.
 c. Sam told *the boy* that Mary kissed him.
 d. Sam told *every boy* that Mary kissed him.

The question is how likely a child is to take *him* to be coreferential with the italicized NP in these examples. If subjects show a tendency to assign *him* the subject as antecedent more often in (23a) than in (23b), and to select the object as antecedent more often in (23c) than in (23d), this would demonstrate the existence of a baseline bias against a bound variable interpretation for the pronoun. (Note that any bias toward taking the subject or object as antecedent is controlled for in these pairs.)

For example, when presented with a sentence like (23b), a child can construct (at least) two possible interpretations. In one, *him* has *Sam* as its antecedent. In the other, *him* is a variable bound by the quantifier *every boy*. Suppose that the second interpretation is more complex than the first and that it will therefore be constructed less often than the first interpretation. There will be some trials where the subject has not constructed the bound variable reading and would reject a picture corresponding to that interpretation. When the antecedent is a referential expression, such as *the boy*, the two interpretations are of roughly equal complexity. The child constructs both the readings and will therefore always accept the sentence-picture pair.

Now recall that the critical fact discovered by Chien and Wexler is that children reject bound variables that violate Principle B more often than they reject referential pronouns that do so. Given the reasoning just established, the subject who is judging an illicit sentence-picture pair involving the bound variable reading, such as (18b), has

two reasons to reject it. First, the sentence violates Principle B under the interpretation given by the picture. Second, the subject will fail to construct the bound variable reading in the first place on some percentage of trials. Only one of these reasons for rejection is operative in the case where the pronoun is referential, as in (18a). Let us examine the set of possible trials under this scenario. On each trial involving a referential pronoun that violates Principle B, a subject may either reject the picture-sentence pair because of the binding theory violation, or accept it. On each trial involving a bound variable that violates Principle B, a subject may accept the picture-sentence pair, may reject it because of the Principle B violation, may reject it because of nonavailability of a bound variable interpretation, or may reject it for both of the last two reasons. Let us designate by x the percentage of rejections due to the binding theory, and by y the percentage of rejections due to nonavailability of the bound variable interpretation. What will be the total number of rejections? The answer depends on what assumption we make about the interaction of the reasons for rejection. If the two reasons for rejection are incompatible and never operate on the same trial, the total percentage of rejections will be $x + y$. This seems to be the most likely situation in the present instance: a subject who has not constructed the bound variable reading has not analyzed the pronoun as bound to the local antecedent, whereas a subject who rejects the sentence because of the binding theory *must* have analyzed the pronoun as bound to the local antecedent.¹⁹

Under this interpretation of children's responses to such sentences, child subjects who miss the bound variable interpretation on 20% of trials, and reject Principle B violations on 60% of trials, will reject Principle B violations involving bound variables on 80% of trials. These subjects will correctly reject ill-formed sentence-picture pairs more often for bound variables than for referential pronouns, even if the binding theory treats them identically. It is important to emphasize that this explanation does not require that children lack command of the grammar of bound variables, or that they never construct bound variable interpretations. It simply requires a discrepancy between the construction of bound variable readings and referential readings for pronouns.

In addition, Chien and Wexler looked at performance on bound variable and referential reflexives in sentences like those in (24).

- (24) a. Is Mama Bear washing herself?
 b. Is every bear washing herself?

They found that in the anaphor cases, there is no improvement for the bound variable interpretation. Chien and Wexler's hypothesis predicts exactly this, because anaphors, unlike pronouns, are subject to the binding theory regardless of whether or not they are bound variables.

However, the difference between anaphors and pronouns can probably be explained

¹⁹ If the two reasons are maximally overlapping, the total percentage of rejections will be whichever of x and y is larger, since both reasons will be operative in all trials where both can be operative. Otherwise, the total percentage of rejections will be somewhere between $x + y$ and the maximum of x and y .

under the hypothesis that it is the complexity of the bound variable that is affecting children's performance on this task. Why would performance on anaphors not improve when they are bound variables, just like performance on the pronouns? There is one critical difference between correct performance on anaphors and correct performance on pronouns. For both of the comparisons—(18a) and (18b), and (24a) and (24b)—the pictures that the children see depict Mama Bear or three bears performing a reflexive washing action. Correct performance for anaphor bound variables thus involves *acceptance*, whereas correct performance on pronominal bound variables involves *rejection*.

Consider (25) for example.

- (25) a. Is every bear washing herself?
 b. Is every bear washing her?

The bound variable interpretation in each sentence requires coindexing between the subject NP and the object NP. Hence, the bound variable interpretation is always grammatical when the object is an anaphor and always ungrammatical when the object is a pronoun. In the context of the interpretation required by the picture, the correct answer for the bound variable reading is acceptance for (25a) and rejection for (25b).

If subjects sometimes fail to construct bound variable interpretations for anaphors, as for pronouns, they will tend to reject grammatical sentences using anaphors. So under the bound variable interpretation, "no" responses will increase for both pronouns and anaphors. Since "no" responses are correct for pronouns and incorrect for anaphors, the bound variable interpretation raises the percent correct for pronouns and reduces the percent correct for anaphors.

The prediction is, therefore, that if bound variable interpretations are not always available to subjects, we will find a pattern of responses in which performance on bound variable pronouns is higher than performance on referential pronouns, and performance on bound variable anaphors is lower than performance on referential anaphors. In fact, if we compare Chien and Wexler's results for anaphors and pronouns, there does appear to be a small but consistent difference in the predicted direction.

We have suggested here that the high rejection rate for bound variable pronouns that violate Principle B reflects a high rejection rate for pronouns as bound variables. Thus, there are again two different kinds of interpretations for the experimental data. One implicates knowledge of the binding theory in a particular form. The other does not.

4. Conclusion

The hypothesis that children do indeed know the binding theory, but do not reliably obey it under all circumstances, allows us to make sense out of the otherwise conflicting data that have been gathered in the experiments in the area. Children do not perform perfectly, but they are regularly and consistently above chance. Even though they do not seem quite sure what to do about the BT-ungrammatical sentences, they apparently

never treat them just like they treat the BT-grammatical sentences—which is exactly what they should do if they do not know the relevant aspects of the binding theory. Various properties of anaphors and pronouns, and of the experiments that evaluate their status, conspire to produce generally low performance on pronouns relative to anaphors. It goes without saying that there must be many more such factors that we have not considered, and that no single factor can be held responsible for the experimental results.

Would the perfect experiment necessarily show that children's command of pronouns is equivalent to their command of anaphors? Is it the case that the relative performance of subjects in these two areas is ultimately attributable to experimental ineptitude on our own part as well as on the part of many other people? The answer may be positive—it may be that once the factors that perturb performance are more completely understood, it will be possible to extract scores on Principle B sentences that match those on Principle A. However, it seems at least as likely that the answer is negative. There is one irremediable difference between (local) anaphors and pronouns: anaphors always have a local grammatical antecedent, pronouns never do. No experimental design can equate for this property, which may yield a fundamental difference in processing difficulty and result in inevitably different performance on anaphors and pronouns.

Even if this should turn out to be the case, however, the nature of the knowledge underlying performance can still be detected. The inevitable screening effects of processing demands and other performance factors do not prevent us from establishing the character of linguistic knowledge; they just make it more challenging. In the example considered in this article, an analysis of these performance factors makes it possible to see, if only dimly, through the performance filter. Under the resulting interpretation of the data, children's knowledge of the binding theory is fully consistent with the general thrust of research into Universal Grammar: the binding theory appears to be innate, and children seem to know it.

Appendix

A.1. Method

A.1.1. Subjects. Twelve subjects from two Massachusetts daycare centers (one in the suburban Boston area, and one in western Massachusetts) participated in the study. Of the 12, 5 were female and 7 male. The children ranged from 4 to 5 years of age.

A.1.2. Target Sentences. The test sentences were divided into four basic sentence types, as listed in (26).

(26) Sentence Types

- a. Principle B: Bert_i patted him_{-i/j}.
- b. Principle C: He_i hit Bert_{-i/j}.
- c. Principle C: He_i said that Bert_{-i/j} moved the box.
- d. No violation: Bert_i said that he_{i/j} jumped on the box.

In each sentence, the pronoun refers either to an NP in the sentence or to a previously mentioned NP. Though all four sentences are grammatical, for types (26a–c) internal coreference is ungrammatical; for type (26d) both readings are grammatical (where *he* has ambiguous reference). In total, then, there were 8 sentence types (including both readings). Each was presented twice, giving 16 target sentences. In section 2.1 we analyzed only the data from simple sentence types (26a) and (26b).

A.1.3. Discourse Antecedent. Each target sentence was preceded by a "context" sentence in order to provide an antecedent for the pronoun. The context sentence introduced the two participants in the scenario; the subject of the context sentence always constituted a potential antecedent for the pronoun in the target sentence (see section 3.1). An example is "Bert was standing next to Oscar. He hit Oscar."

A.1.4. Fillers/Foils. Four additional sentences were interspersed among the target sentences. These contained reflexives rather than pronouns and were designed to remind the subject to attend to the reference of the anaphor. In total, then, there were 20 trial sentences (16 target sentences and 4 fillers). Fillers included sentences like "Bert hit/hugged/patted himself."

A.2. Procedure

A.2.1. Instructions. The children were told that a frog puppet (Froggie) was learning to speak English (as opposed to Frog Language). Their task was to help teach Froggie the difference between *him* and *himself*. The experiment began with 4–8 training trials (the actual number depending upon the speed at which the subject learned the mechanics of the task). The training trials consisted of sentences with reflexives.

A.2.2. Testing. The experimenters elicited truth-value judgments from young children using a modified version of Crain and McKee's (1985) Truth-Value Judgment Task. (This methodology was also tested in a study by Eisele and Lust (1989) and again found to be a useful method for testing young children.) The stimuli included videotaped scenarios, consisting of short events acted out by *Sesame Street* puppets. For instance, Bert hit Oscar, or Big Bird patted Ernie on the back. The child watched the scenarios (each was viewed twice). After each scenario, a frog puppet, manipulated by an experimenter, said two sentences: the "context" sentence and the target sentence. The context sentence named each puppet in the scenario. The target sentence described the event. Care was taken not to emphasize or stress the pronoun in the target sentence (see section 3.4). After the frog puppet had spoken, the child indicated whether or not Froggie had correctly said what happened in the event. A child who thought the frog was right fed him a cookie; a child who thought the frog was wrong fed him a rag.

A typical trial went like this: The child watched a scenario on the TV two times (a typical scenario was that Bert hit Oscar). Between the two viewings of the scenario, the experimenter talked with the child about the scene (to aid in memory), without using any third person pronouns (for example, "Look who's there; Bert just hit Oscar"). After

the second repetition of the scenario. Froggie quickly recited the context and target sentences: "Bert was fighting with Oscar. He hit Oscar." At this point, the child judged the sentence (by feeding Froggie either the cookie or the rag). Sample scenarios and test sentences are listed in (27)–(30).²⁰

(27) *Principle B–Simple*

a. BT-Grammatical

Scenario: Big Bird pats Ernie.

Froggie: I saw Big Bird doing something with Ernie. Big Bird, patted him,.

b. BT-Ungrammatical

Scenario: Big Bird hits himself.

Froggie: Big Bird was standing with Ernie. *Big Bird, hit him,.

(28) *Principle C–Simple*

a. BT-Grammatical

Scenario: Ernie pats Big Bird.

Froggie: I just saw Ernie do something with Big Bird. He, patted Big Bird,.

b. BT-Ungrammatical

Scenario: Ernie hits himself.

Froggie: Ernie was fighting with Big Bird. *He, hit Ernie,.

(29) *Principle C–Complex*

a. BT-Grammatical

Scenario: Oscar moves a box. Bert says to Oscar, "You're moving the box."

Froggie: Bert was talking to Oscar. He, said that Oscar, moved the box.

b. BT-Ungrammatical

Scenario: Bert touches a box. Bert says to Oscar, "I'm touching the box."

Froggie: Bert was with Oscar. *He, said that Bert, touched the box.

(30) *Ambiguous Reference–Complex*

a. BT-Grammatical

Scenario: Ernie jumps on a box. Big Bird says to Ernie, "You're jumping on the box."

Froggie: Ernie was doing something with Big Bird. Big Bird, said that he, jumped on the box.

²⁰ Results from (27) and (28) only were analyzed in section 2.1.

b. BT-Grammatical

Scenario: Bert runs back and forth behind a box. Bert says to Oscar, "I'm running around behind the box."

Froggie: Bert was talking to Oscar. Bert, said that he, ran behind the box.

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