1. INTRODUCTION

This paper presents the results of our recent experimental investigations of a central issue in linguistic theory: which properties of human language are innately determined? There are two main sources of information to be tapped to find the answer to this question. First, universal properties of human languages are plausibly (even if not necessarily) taken to be innately determined. In addition, properties that emerge in children's language in the absence of decisive evidence in their linguistic input are reasonably held to be innate. Clearly, it would be most satisfactory if these two diagnostics for what is innate agreed with each other. In some cases they do. For example, there is a universal principle favoring transformational movement of phrases rather than of lexical categories e.g., topicalization of noun phrases but not of nouns. To the best of our knowledge children abide by this principle; they may hear sentences such as *Candy, you can't have now, but they don't infer that nouns can be topicalized. If they did, they would say things like *Vegetables, I won't eat the. But this is not an error characteristic of children. Instead, from the moment they produce topicalized constructions at all, they apparently produce correct NP-topicalized forms such as The vegetables, I won't eat.

In recent years, this happy convergence of results from research on universals and research on acquisition has been challenged by experimental studies reporting various syntactic failures on the part of children. The children in these experiments are apparently violating putatively universal phrase structure principles or constraints on transformations. Failure to demonstrate early knowledge of syntactic principles is reported by Jakubowicz (1984), Lust (1981), Matthei (1981, 1982), Phinney (1981), Roeper (1986), Solan and Roeper (1978), Tavakolian (1978, 1981) and Wexler and Chien (1985). Some explanation is clearly called for if a syntactic principle is respected in all adult languages but is not respected in the language of children.

Assuming that the experimental data accurately reflect children's linguistic competence, there are several possible responses to the unaccommodating data. The most extreme would be to give up the innateness claim for the principle in question. One might look for further linguistic data which show that it isn't universal. Or one might abandon the hypothesis that all universal principles are innate. For instance, Matthei (1981) obtained results that he interpreted as evidence that universal constraints on children's interpretation of reciprocals are learned, not innate. However, this approach is plausible only if one can offer some other explanation (e.g., functional explanation) for why the constraints should be universal. But this is not always easy; as Chomsky (1986) has emphasized, many properties of natural language are arbitrary and have no practical motivation.

A different response to the apparent failure of children to respect constraints believed to be innate is to argue that the constraints are as yet inapplicable to their sentences. The claim is that as soon as a child's linguistic analyses have reached the level of sophistication at which a
The Perception of Phonetic Gestures


**FOOTNOTES**


2Also Dartmouth College, Hanover, New Hampshire.

3University of California at Riverside, Department of Psychology.

4There is a small qualification to the claim that listeners cannot tell what contributions visible and audible information each have to their perceptual experience in the McGurk effect. Massaro (1987) has shown that effects of the video display can be reduced but not eliminated by instructing subjects to look at, but to ignore, the display.

5Liberman et al. identify a cipher as a system in which each unique unit of the message maps onto a unique symbol. In contrast, in a code, the correspondence between message unit and symbol is not 1:1.

6Liberman et al. propose to replace the more conventional view of the features of a pheme (for example, that of Jakobson, Fant & Halle, 1951) with one of features as “implicit instructions to separate and independent parts of the motor machinery” (p. 446).

7With one apparent slip on page 2: “The objects of speech perception are the intended acoustic gestures of the speaker, represented in the brain as invariant motor commands….”

8One can certainly challenge the idea that listeners recover the very gestures that occurred to produce a speech signal. Obviously there are no gestures at all responsible for most synthetic speech or for “sine-wave speech” (e.g., Remez, Rubin, Pisoni, & Carrell, 1981) and quite different behaviors underlie a parrot’s or mynah bird’s mimicking of speech. The claim that we argue is incontrovertible is that listeners recover gestures from speech-like signals, even those generated in some other way. (We direct realists [Fowler, 1986a,b] would also argue that “misperceptions” (hearing phonetic gestures where there are none) can only occur in limited varieties of ways—the most notable being signals produced by certain mirage-producing human artifacts, such as speech synthesizers or mirage-producing birds. Another, however, possibly, includes signals produced to mimic those of normal speakers by speakers with pathologies of the vocal tract that prevent normal realization of gestures.)

9There are two almost orthogonal perspectives from which perception can be studied. On the one hand, investigators can focus on processes inside the perceiver that take place from the time that a sense organ is stimulated until a percept is achieved or a response is made to the input. On the other hand, they can look outside the perceiver and ask what, in the environment, the organism under study perceives, what information in stimulation to the sense organs allows perception of the things perceived, and finally, whether the organisms in fact use the postulated information. Here we focus on this latter perspective, most closely associated with the work of James Gibson (e.g., 1966; 1979; Reed & Jones, 1982).

10It is easy to find examples in which perception is heteromorphic with respect to the proximal stimulation and homomorphic with respect to distal events—looming, for example. We can also think of some examples in which perception appears homomorphic with respect to proximal stimulation, but in the examples we have come up with, they are homomorphic with respect to the distal event as well (perception of a line drawn by a pencil, for example), and so there is no way to decide whether perception is of the proximal stimulation or of the distal event. We challenge the motor theorists to provide an example in which perception is homomorphic with structure in proximal stimulation that is not also homomorphic with distal event structure. These would provide convincing cases of proximal stimulation perception.

11Bregman (1987) considers duplex perception to disconfirm his “rule of disjoint allocation” in acoustic scene analysis by listeners. According to the rule, each acoustic fragment is assigned in perception to one and only one environmental source. It seems, however, that duplex perception does not disconfirm the rule.

12Using a more sensitive, AXB, test, however, we have found that listeners can match the metal door chirp, rather than a wooden door chirp, to the metal door slam at performance levels considerably better than chance.
universal constraint becomes relevant, then that constraint will be respected. For example, Otsu (1981) has argued that children who give the appearance of violating a universal constraint on extraction may not yet have mastered the structure to which the constraint applies; they may have only some simpler approximation to the construction, lacking the crucial property that engages the constraint. We will discuss the evidence for this below.

A different approach also accepts the recalcitrant data as valid, but rejects the inference that the data are inconsistent with the innateness hypothesis. It is pointed out that it is possible for a linguistic principle to be innately encoded in the human brain and yet not accessible to the language faculty of children at early stages of language acquisition. The principle in question might be biologically timed to become effective at a certain maturational stage. Like aspects of body development (e.g., the secondary sex characteristics), linguistic principles might lie dormant for many years. One recent proposal invoking linguistic maturation, by Borer and Wexler (1987), contends that a syntactic principle underlying verbal passives undergoes maturational development. They maintain that before a critical stage of maturation is reached, children are unable to produce or comprehend passive sentences (full verbal passives with by-phrases).

It may eventually turn out that the innateness hypothesis must be augmented by maturation assumptions in certain cases. But such assumptions introduce new degrees of freedom into the theory, so its empirical claims are weakened. Unless some motivated predictions can be made about exactly when latent knowledge will become effective, a maturational approach is compatible with a much wider range of data than the simplest and strongest version of the innateness hypothesis, viz. that children have access to the same set of universal principles at all stages of language development. This more restricted position is the one to be adopted until or unless there is clear evidence to the contrary, e.g., clear evidence of a period or a stage at which all children violate a certain constraint, in all constructions to which it is applicable, simple as well as complex, and in all languages. So far, no such case has been demonstrated.

Our research has taken a different approach. We argue that the experimental data do not unequivocally demonstrate a lack of linguistic knowledge. We do not deny that children do sometimes misinterpret sentences. But the proper interpretation of such failures is complicated by the existence of a variety of potentially confounding factors. Normal sentence comprehension involves lexical, syntactic, semantic, pragmatic and inferential abilities, and the failure of any one of these may be responsible for poor performance on an experimental task. It is crucial, therefore, to develop empirical methods which will distinguish between these various factors, so that we can determine exactly where a child's deficiencies lie. Until this has been done, one cannot infer from children's imperfect performance that they are ignorant of the grammar of their target language.

In fact it can be argued in many cases that it is non-syntactic demands of the task which are the cause of children's errors. We propose that task performance is weak at first and improves with age in large part because of maturation of non-linguistic capacities such as short term memory or computational ability, which are essential in the efficient practical application of linguistic knowledge. This does not deny that many aspects of language must be learned and that there is a time when a child has not yet learned them. But our interpretation of the data does make it plausible that young children know more of the adult grammar than has previously been demonstrated, and also, most significantly, that their early grammars do abide by universal principles.

In support of this non-linguistic maturation hypothesis, we have reexamined and supplemented a number of earlier experimental findings with demonstrations that nonsyntactic factors were responsible for many of the children's errors. The errors disappear or are greatly reduced when these confounding factors are suitably controlled for. In this paper, we report on a series of experimental studies along these lines concerned with three kinds of nonsyntactic factors in language performance: parsing, plans, and presuppositions. We will argue that these other factors are crucially involved in the experimental tasks by which children demonstrate their knowledge, and that they impose significant demands on children. If we underestimate the demands of any of these other components of the total task we thereby underestimate the extent of the child's knowledge of syntax. As a result, the current estimate of what children know about language is misleading.
2. CHILDREN’S ERRORS IN COMPREHENSION

In this section we attempt to identify and isolate several components of language-related skills, in order to gain a better understanding of each, and to clarify the relationship between the innateness hypothesis and early linguistic knowledge. Very little work has been done on this topic. The majority of language development studies seem to take it for granted that the experimental paradigms provide a direct tap into the child’s linguistic competence. An important exception is a study by Goodluck and Tavakolian (1982), in which improved performance on a relative clause comprehension task resulted from simplification of other aspects of the syntax and semantics of the stimulus sentences (i.e., the use of intransitive rather than transitive relative clauses, and relative clauses with one animate and one inanimate noun phrase rather than two animates). The success of these manipulations is exactly in accord with our general hypothesis about the relation between competence and performance. As other demands on the child’s performance are reduced, greater competence is revealed.

Our experiments focus on three factors involved in many child language experiments which may interfere with estimation of the extent of children’s linguistic knowledge in tasks which are designed to measure sentence comprehension. These factors—parsing, presupposition and plans—are of interest in their own right, but have received very little attention in previous research on syntax acquisition. In this section we will review our recent work on these topics. In the following section we will turn to an alternative research strategy for assessing children’s knowledge, the technique of elicited production.

2.1. Parsing

2.1.1. Subjacency. One universal constraint which should be innate is Subjacency. Subjacency prohibits extraction of constituents from various constructions, including relative clauses. However, in an experimental study by Otsu (1981), many children responded as if they allowed extraction from relative clauses in answering questions about the content of pictures. For example, children saw a picture of a girl using a crayon to draw a monkey who was drinking milk through a straw. They were then asked to respond to question (1).

(1) What is Mary drawing a picture of a monkey that is drinking milk with?

Otsu found that many children responded to (1) in a way that appeared to violate Subjacency. In this case, the answer that is in apparent violation of Subjacency is “a straw.” This is because “a straw” is appropriate only if the what has been moved from a position in the monkey drinking milk clause as shown in (2a), rather than from the Mary drawing picture clause as shown in (2b).

(2) a) *What is Mary drawing a picture of a monkey [that is drinking milk with _]?

b) What is Mary drawing a picture of a monkey [that is drinking milk] with _?
But the *monkey drinking milk* clause is a relative clause, and Subjacency prohibits the *what* from moving out of it. Thus the only acceptable structure is (2b), and the only acceptable answer is “a crayon.” If these data are interpreted solely in terms of children’s grammatical knowledge, then the conclusion would then have to be that knowledge of Subjacency sets in quite late in at least some children.

As we noted earlier, Otsu suggested that the innateness of Subjacency could be salvaged by showing that the children who appeared to violate Subjacency had not yet mastered the phrase structure of relative clauses (of sufficient complexity to contain an extractable noun phrase). When he conducted an independent test of knowledge of relative clause structure, he found, as predicted, a correlation between phrase structure and Subjacency application in the children’s performance. However, the children’s performance was still surprisingly poor: 25% of the children who were deemed to have mastered relative clauses gave responses involving ungrammatical Subjacency violating extractions from relative clauses.

We have argued (Crain & Fodor, 1984) for an alternative analysis of Otsu’s data, which makes it possible to credit children with knowledge of both phrase structure principles and constraints on transformations from an early age. We claim that children’s parsing routines can influence their performance on the kind of sentences used in the Subjacency test; in particular, that there are strong parsing pressures encouraging subjects to compute the ungrammatical analysis of such sentences. Until a child develops sufficient capacity to override these parsing pressures, they may mask his syntactic competence, making him look as if he were ignorant of Subjacency.

A powerful general tendency in sentence parsing by adults is to attach an incoming phrase low in the phrase marker if possible. This has been called Right Association; see Kimball (1973), Frazier and Fodor (1978). In sentence (3), for example, the preferred analysis has *with NP modifying drinking milk* rather than modifying *drawing a picture*, even though in this case both analyses are grammatically well-formed because there has been no WH-movement.

(3) Mary is drawing a picture of a monkey that is drinking milk with NP.

To see how strong this parsing pressure is, note how difficult it is to get the sensible interpretation of (3) when *a crayon* is substituted for NP. This Right Association preference is still present if the NP in (3) is extracted, as in (1). The word *with* in (1) still coheres strongly with the relative clause, rather than with the main clause. The result is that the analysis of (2) that is most immediately apparent is the ungrammatical (2a) in which *what* has been extracted from the relative clause. Since this ‘garden path’ analysis is apparent to most adults, it is hardly surprising if some of Otsu’s child subjects were also tempted by it and responded to (1) in the picture verification task by saying “a straw” rather than “a crayon.”

We conducted several experiments designed to establish the plausibility of this claim that the relatively poor performance of children on sentences like (1) is due to parsing pressures rather than to ignorance of universal constraints. In the first experiment, we tested children and adults on complement-clause questions as in (4). Subjacency does not prohibit extraction from complement clauses, so if there were no Right Association effects this sentence should be fully ambiguous, with both interpretations equally available.

(4) What is Bozo watching the dog jump through?

That is, given a picture in which Bozo the clown is looking through a keyhole at a dog jumping through a hoop, it would be correct to say either the “the keyhole” or “a hoop.” Intuitively, though, the interpretations are highly skewed for adults, with a strong preference for the Right Association interpretation (“hoop”) in which the preposition attaches within the lower clause. Our experiment showed that the same is true for children. We tested twenty 3- to 5-year-olds (mean age 4;6) on these sentences using a picture verification task just like Otsu’s, and 90% of their responses were in accord with the Right Association interpretation.²

Thus children and adults alike are strongly swayed by Right Association. This is an important result. To the best of our knowledge the question of whether children’s parsing strategies resemble those of adults has not previously been investigated. But children certainly should show the same preferences as adults, if the human sentence parsing mechanism is innately structured. And the parsing mechanism certainly should be innately structured, because it would be pointless to be born knowing a lot of facts about language if one weren’t also born knowing how to use those facts for speaking and understanding. It is satisfying, then, to have shown that children
exhibit Right Association. And the fact that they do offers a plausible explanation for why so many of them failed Otsu's Subjacency test—they were listening to their parsers rather than to their grammars.

Our other experiments in support of this conclusion were designed to show that even people whose knowledge of Subjacency is not in doubt—i.e., adults—are also tempted to violate Subjacency when it is in competition with Right Association. We ran Otsu's Subjacency test on adults just as he did with the children. The adults gave Subjacency-violating low attachment responses to 21% of these questions. This was not quite as high a rate as for the children, but as we have noted, adults surely have a greater capacity than children do for checking an illicit analysis and shifting to a less preferred but well-formed analysis before they commit themselves to a response. In an attempt to equalize adult self-monitoring capacities with those of children, we re-ran the Subjacency experiment with an additional distracting task (= listening for a designated phoneme in the stimulus sentence). Under these conditions the adults gave Subjacency violating responses to 29% of the relative clause constructions, a slightly higher rate than the 25% for Otsu's child subjects.

Escalating still further, we changed the sentences so that the grammatically well-formed analysis was semantically or pragmatically anomalous, as in (5).

(5) What color hat is Barbara drawing a picture of an artist with?

Under these circumstances, where the semantics clearly favored the Subjacency-violating analysis, 75% of adults' responses violated Subjacency. This makes it very clear that linguistic competence may not always be revealed by linguistic performance.

Finally, we ran another study, in which we asked adults to classify sentences as ambiguous or unambiguous. The sentences were spoken in turn with only a few seconds between them, and there were 72 of them, so the task was fairly demanding. The materials included complement questions like (4) and relative clause questions like (1), as well as ambiguous and unambiguous control sentences of many varieties. The results showed a 62% ambiguity detection rate for the ambiguous control sentences, with a 16% ‘false alarm’ rate for the unambiguous control sentences. Thus the subjects were able to cope with the task tolerably well, though not perfectly. What was interesting was that the ambiguity of the complement questions was detected only 48% of the time, in line with our claim that Right Association obscures the alternative reading with the prepositional phrase in the main clause. And most interesting of all was that 80% of the relative clause questions were judged to be ambiguous, even though Subjacency prohibits one analysis and renders them unambiguous. Our explanation for this extraordinary result is that the subjects first computed the Right Association analysis favored by their parsing routines, then recognized that this was unacceptable because of Subjacency, and so rejected it in favor of the analysis with the prepositional phrase in the main clause. We assume that it was this rapid shift from one analysis to the other that gave our subjects such a strong impression that these sentences were ambiguous. Note that if this misanalysis-revision occurs 80% of the time for adults, only a slight handicap in children's ability to revise would be sufficient to account for their errors.

To sum up: we still have no positive proof that Subjacency is innate, but at least now there is no evidence against it. Our experiments make it plausible that children as young as can be tested are like adults both with respect to their knowledge of this universal constraint and with respect to their parsing routines—they are just not very good yet at coping with conflicts between the two.

2.1.2. Backward pronominalization. A fundamental constraint on natural language is the structure dependence of linguistic rules. The innateness hypothesis implies that children's earliest grammars should also exhibit structure dependence—even if their linguistic experience happens to be equally compatible with structure-independent hypotheses. However, it has been proposed that children initially hypothesize a structure-independent constraint on anaphora, prohibiting all cases of backward pronominalization (Solan, 1983). Backward pronominalization consists of coreference between a noun phrase and a preceding pronoun, as indicated by the indices in (6).

(6) That he kissed the lion made the duck happy.

We will argue that children do in fact permit backward pronominalization, subject to structure-dependent constraints. We contend that the appearance of a general restriction against backward pronominalization is due to a parsing preference for the alternative 'extra-sentential'
reading of the pronoun in certain comprehension tasks. The results of a new comprehension methodology show that children as young as 2;10 admit the same range of interpretations for pronouns as adults do.

Two sources of evidence have been cited as evidence that children up to 5 or 6 years uniformly reject backward pronominalization. First, children who are asked to repeat back a sentence such as (7) often respond by converting it into a forward pronominalization construction, as in (8) (Lust, 1981).

(7) Because she was tired, Mommy was sleeping.

(8) Because Mommy was tired, she was sleeping.

The fact that these children took the trouble to exchange the pronoun and its antecedent certainly indicates that they disfavor backward pronominalization in their own productions. But it does not show that the backward pronominalization interpretation is not compatible with the child’s grammar, as suggested by Solan (1983). To the contrary, the conversion of (7) to (8) shows that children do accept backward pronominalization in comprehension; for they would think of (8) as an acceptable variant of (7) only if they were interpreting the pronoun in (7) as coreferential with the subsequent lexical noun phrase (Lasnik & Crain, 1985).

Second, it has been found that when the acting-out situation for a sentence like (6) includes a potential referent for he other than the duck (e.g., a farmer), this unmentioned object is usually favored by the children as the referent of the pronoun (Solan, 1983; Tavakolian, 1978). In contrast to the prevailing view, we would attribute this to a parsing preference for the extra-sentential interpretation of the pronoun; it does not have to be taken as evidence that children have a grammatical prohibition against backward anaphora. Our suggestion, then, is that children’s knowledge might be comparable to that of adults, even if their performance differs.

It is particularly important to keep this distinction in mind for potentially ambiguous constructions such as these. When a sentence has more than one possible interpretation, the interpretation that children select can tell us which interpretation they prefer; it cannot show that others are unavailable to them. After all, adults also exhibit biases in connection with ambiguous constructions, but this does not lead us to accuse them of ignorance of alternative interpretations. To establish how much children actually do know, we should look for the factors that might be biasing their interpretations, and also for ways of minimizing this bias so that interpretations which are less preferred but nevertheless acceptable to them have a chance of showing through.

The most likely general source of bias against backward pronominalization is the fact that interpretation of the pronoun would have to be delayed until the antecedent is encountered later in the sentence. This retention of uninterpreted items may strain a child’s limited working memory. There is some evidence for this speculation. Hamburger and Crain (1984) have noted that children show a tendency to interpret adjectives immediately, without waiting for the remainder of the noun phrase, even in cases where this leads them to give incorrect responses. And Clark (1971) has observed errors attributable to children’s tendency to act out a clause immediately without waiting for other clauses in the sentence. The only way to interpret the pronoun immediately in a sentence like (6) is to assign it an extra-sentential referent, as children typically do.

If this proposal is correct, it should be that children will accept backward pronominalization in an experimental task that presses subjects to access every interpretation they can assign to a sentence. Crain and McKee (1985) used a true/false paradigm in which subjects judge the truth value of sentences against situations acted out by the experimenter. The sentences were as in (9), where either a coreferential reading or an extra-sentential reading of the pronoun is possible.

(9) When he went into the barn, the fox stole the food.

On each trial, a child heard a sentence following a staged event acted out by one of two experimenters, using toy figures and props. The second experimenter manipulated a puppet, Kermit the Frog. Following each event, Kermit said what he thought had happened on that trial. The child’s task was to indicate whether or not the sentence uttered by Kermit accurately described what had happened. Children were asked to feed Kermit a cookie if he said the right thing, that is, if what he said was what really happened. In this way, ‘true’ responses were encouraged in the experimental situation. But sometimes Kermit would say the wrong thing, if he wasn’t paying close attention. When this happened, the child was asked to make Kermit eat a rag. (In pilot
work without the rag ploy, we had found that children were reluctant to say that Kermit had said something wrong.)

To test for the availability of both interpretations of an ambiguous sentence like (9), children judged it twice during the course of the experiment, once following a situation in which a fox stole some chickens from inside a barn (for the backward pronominialization interpretation), and once following a situation in which a man stole some chickens while a fox was in a barn (for the extra-sentential interpretation).

Children accepted the backward anaphora reading for all the ambiguous sentences 73 of the time. The extra-sentential reading was accepted 81 of the time, but the difference was not significant. Much the same results were obtained even for the 7 youngest children, whose ages were from 2;10 to 3;4. Only two of the 62 subjects consistently rejected the backward anaphora reading. Thus most children find the backward anaphora reading acceptable, although it might not be preferred if they were forced to choose between interpretations, as in previous comprehension studies.

We should note that a variety of control sentences were also tested to rule out other, less interesting, explanations of the children's performance. For example, the children rejected sentence (10) following a situation in which Strawberry Shortcake did eat an ice cream, but not while she was outside playing. This shows that they were not simply ignoring the subordinated clauses of sentences in deciding whether to accept or reject them.

(10) When she was outside playing, Strawberry Shortcake ate an ice cream.

Sentences like (11) were also tested in order to establish that subjects were not merely giving positive responses to all sentences, regardless of their grammatical properties.

(11) He stole the food when the fox went into the barn.

The difference between (11) and the acceptable backward pronominialization in (9) is that in (11) the pronoun is in the higher clause and c-commands the fox, while in (9) the pronoun is in the subordinate clause and does not c-command the fox. (A node A in a phrase marker is said to c-command a node B if there is a route from A to B which goes up to the first branching node above A, and then down to B. Note that c-command is a structure-dependent relation.) There is a universal constraint that prohibits a pronoun from c-commanding its antecedent. And indeed the children did reject (11) 87% of the time. Note that this positive result shows that the children have early knowledge not only of the absence of linear sequence conditions on pronominalization, but also of the existence of structural conditions such as c-command. (See also Lust, 1981, and Goodluck, 1986.)

2.1.3. Subject/Auxiliary Inversion. Another study (Crain & Nakayama, 1987) also explored the tie between children's errors in acquisition tasks and sentence processing problems. This study was designed to test whether children give structure-dependent or structure-independent responses when they are required to transform sentences by performing Subject/Auxiliary inversion. As Chomsky (1971) pointed out, transformational rules are universally sensitive to the structural configurations in the sentences to which they apply, not just to the linear sequence of words.

The procedure in this study was simply for the experimenter to preface declaratives like (12) with the carrier phrase “Ask Jabba if ...," as in (13).

(12) The man who is running is bald.

(13) Ask Jabba if the man who is running is bald.

The child then had to pose the appropriate yes/no questions to Jabba the Hutt, a figure from “Star Wars" who was being manipulated by one of the experimenters. Following each question, Jabba was shown a picture and would respond “yes” or “no.”

The sentences all contained a relative clause modifying the subject noun phrase. The correct structure-dependent transformation moves the first verb of the main clause to the front of the sentence, past the whole subject noun phrase, as in (14). An incorrect, structure-independent transformation would be as in (15), where the linearly first verb in the word string (which happens to be the verb of the relative clause) has been fronted.

(14) Is the man who is running bald?

(15) *Is the man who running is bald?

For simple sentences with only one clause such as (16), which are more frequent in a young child's input, both versions of the transformation rule give the correct result.

(16) Ask Jabba if the man is bald.

(17) Is the man bald?
It is only on the more complex sentences that the form of the child’s rule is revealed.

The outcome was as predicted by the innateness hypothesis: children never produced an incorrect sentence like (15). Thus, a structure-independent strategy was not adopted in spite of its simplicity and in spite of the fact that it produces the correct question forms in many instances. The findings of this study thus lend further support to the view that the initial state of the human language faculty contains structure-dependence as an inherent property.

The children did make some errors in this experiment, and we observed that most of them were in sentences with a long subject noun phrase and a short main verb phrase, as in (18).

(18) Is the boy who is holding the plate crying?

By contrast, there were significantly fewer errors in sentences like (19), which has a shorter subject noun phrase and a longer verb phrase.

(19) Is the boy who is unhappy watching Mickey Mouse?

This kind of contrast is familiar in parsing studies with adults. In particular, Frazier and Fodor (1978) showed that a sequence consisting of a long constituent followed by a short constituent is especially troublesome for the (adult) parsing routines; a short constituent before a long one is much easier to parse. The distribution of the children’s errors in the Subject-Auxiliary Inversion task may therefore be indicative not of inadequate knowledge of the inversion rule, but of an adult-like processing sensitivity to interactions between structure and constituent length.

A follow-up study to test this possibility was conducted by Nakayama (1987). Nakayama systematically varied both the length and the syntactic structure of the sentences to be transformed by the children. The children made significantly fewer Subject-Auxiliary Inversion errors in response to embedded questions with short relative clauses (containing intransitive verbs) as compared to those with long relative clauses (containing transitive verbs). With length held constant, the children had more difficulty with relative clauses that had object gaps, as in (20), than with relative clauses that had subject gaps, as in (21) (although this effect was not quite significant).

(20) The ball the girl kicked is rolling.

(21) The boy who was slapped is crying.

The ease of subject gap constructions, as compared to object gap constructions, has been found in a number of other studies in language development, in language impaired populations, and in experiments on adult sentence processing (where the question of syntactic competence is not in doubt). It seems reasonable to interpret these results as confirming that children’s error rates in language tests are highly sensitive to the complexity of the sentence parsing that is required.

2.2. Presupposition

Syntactic parsing is not the only factor that has been found to mask knowledge of syntactic principles. Test sentences whose pragmatic presuppositions are unsatisfied in the experimental situation have been found to result in inaccurate assessments of children’s structural knowledge. In this section we consider two experiments that point to the relevance of presuppositional content in sentence understanding.

The structures we discuss here are relative clauses and temporal adverbial clauses. A word of clarification is needed before we proceed. Up till now we have restricted the scope of the innate hypothesis to universal constraints (like Subjacency, and structure-dependence), which could not in principle be learned from normal linguistic experience (i.e., without extensive corrective feedback). But now we want to extend the innateness hypothesis to a broader class of linguistic knowledge, knowledge of universal types of sentence construction. We cannot plausibly claim that every aspect of these constructions is innate. Rather, every construction will have some aspects that are determined by innate principles, and other aspects that must be learned. And the balance between these two elements varies from construction to construction. So it is perfectly acceptable on theoretical grounds that some constructions should be acquired later than others. However, the innateness hypothesis is not compatible with just any order of acquisition. It predicts early acquisition of constructions that Chomsky calls ‘core’ language, i.e., the constructions that have strong assistance from innate principles with just a few parameters to be set by learners on the basis of experience. It would be surprising to discover that knowledge of these constructions was significantly delayed once the relevant lexical items had been learned. In the absence of a plausible explanation, this would put the innateness hypothesis at risk.
We noted in section 1 a range of possible explanations of apparently delayed knowledge of linguistic facts. In the present case they would include the following:

- the construction does not, after all, belong to the core but is 'peripheral' and hence should be acquired late;
- children don’t hear this construction until quite late in the course of language development and so could not be expected to know it exists;
- the core principles in question undergo maturation and so are not accessible at early stages of acquisition;
- the experimental data are faulty and children do indeed have knowledge of this construction.

We will argue for this last alternative. And just as in the previously described studies of innate constraints, we will lay the blame for the misleading experimental data on the fact that traditional experimental paradigms do not make sufficient allowance for the limited memory and computational capacities of young children. Once again, our story is that non-linguistic immaturity can create the illusion of linguistic immaturity.

2.2.1. Relative Clauses. Children typically make more errors in understanding sentences containing relative clauses (as in 22) than sentences containing conjoined clauses (as in 23), when comprehension is assessed by a figure manipulation (act-out) task.

(22) The dog pushed the sheep that jumped over the fence.

(23) The dog pushed the sheep and jumped over the fence.

The usual finding that (22) is more difficult for children than (23) up to age 6 years or so has been interpreted as an instance of late emergence of the rules for subordinate syntax in language development (e.g., Tavakolian, 1981). However, though coordination may be innately favored over subordination, it is also true that subordination is ubiquitous in natural language; relative clause constructions are very close to the 'core.' So ignorance of relative clauses until age 6 would stretch the innateness hypothesis.

Fortunately this is not how things stand. Hamburger and Crain (1982) showed that the source of children’s performance errors on this task is not a lack of syntactic knowledge. By constructing pragmatic contexts in which the presuppositions of restrictive relative clauses were satisfied, they were able to demonstrate mastery of relative clause structure by children as young as 3 years. There are two presuppositions in (22):

(i) that there are at least two sheep in the context, and
(ii) that one (but only one) of the sheep jumped over a fence prior to the utterance. The reason why previous studies failed to demonstrate early knowledge of relative clause constructions, we believe, is that they did not pay scrupulous attention to these pragmatic presuppositions. For example, subjects were required to act out the meaning of a sentence such as (22) in contexts in which only one sheep was present. The poor performance by young children in these experiments was attributed to their ignorance of the linguistic properties of relative clause constructions. But suppose that a child did know the linguistic properties, but that he also was aware of the associated presuppositions. Such a child might very well be unable to relate his correct understanding of the sentence to the inappropriate circumstances provided by the experiment. Adult subjects may be able to ‘see through’ the unnaturalness of an experimental task to the intentions of the experimenter, but it is not realistic to expect this of young children.

Following this line of reasoning, Hamburger and Crain (1982) made the apparently minor change of adding two more sheep to the acting out situation for sentence (22), and obtained a much higher percentage of correct responses. The most frequent remaining 'error' was failure to act out the event described by the relative clause, but since felicitous usage presupposes that this event has already occurred, this is not really an error but is precisely the kind of response that is compatible with perfect comprehension of the sentence. This interpretation of the data is supported by the fact that there was a positive correlation between incidence of this response type and age.

We have conducted another series of studies on relative clauses, trying several other techniques for assessing grammatical competence. In one study, we employed a picture verification paradigm to see if children could distinguish relative clauses from conjoined clauses, despite the claim of Tavakolian (1981) that they systematically impose a conjoined clause analysis on relatives. In this study, seventeen 3- and 4-year-olds responded to relative clause constructions like (24).

(24) The cat is holding hands with a man who is holding hands with a woman.

(25) The cat is holding hands with a man and is holding hands with a woman.
This sentence was associated with a pair of pictures, one that was appropriate to it and one that was appropriate to the superficially similar conjoined sentence (25). Seventy percent of the 3-year-olds' responses and 94 of the 4-year-olds' responses matched sentences with the appropriate picture rather than with the one depicting the conjoined clause interpretation.

A second technique we tried used a 'silliness' judgment task (see Hsu, 1981) to establish whether children can differentiate relative clauses from conjoined clauses. Ninety-one percent of the responses of the twelve 3- and 4-year-olds tested categorized as 'silly' sentences such as (26), although sentences such as (27) were accepted as sensible 87% of the time.

(26) The horse ate the hay that jumped over the fence.

(27) The man watched the horse that jumped over the fence.

Notice that sentence (26) would not be anomalous if the that-clause were misinterpreted as an and-clause, or if it were interpreted as extraposed from the subject NP; in both cases, the horse would be the understood subject of the relative clause. The results therefore indicate that most children interpret the that-clause in this sentence correctly, i.e., as a subordinate clause modifying the hay. Informal testing of adults suggests that the only respect in which children and adults differ on the interpretation of relative clauses is that the adults are somewhat more likely to accept the extraposed relative analysis as well, though even for adults this analysis is much less preferred.

A third experiment, on the phrase structure of relative clause constructions, indicates that children, like adults, treat a noun phrase and its modifying relative clause as a single constituent, inasmuch as they can construe it as the antecedent for a pronoun such as one.

In a picture verification study, fifteen 3- to 5-year-olds responded to the instructions in (28).

(28) The mother frog is looking at an airplane that has a woman in it. The baby frog is looking at one too. Point to it.

Ninety-three percent of the time the subjects chose the picture in which the baby frog was looking at an airplane with a woman in it, in preference to the picture in which the baby frog was looking at an airplane without a woman in it. That is, the relative clause was included in the noun phrase assigned as antecedent to the pronoun.

In short: the weight of evidence now indicates that children grasp the structure and meaning of relative clause constructions quite early in the course of language acquisition, as would be expected in view of the central position of these constructions in natural language.

2.2.2. Temporal Terms. Another line of research has yielded support for the claim that presupposition failure is implicated in children's poor linguistic performance. These studies employed sentences containing temporal clauses with before and after, as in (29).

(29) Push the red car to me before/after you push the blue car.

Clark (1971) and Amidon and Carey (1972) have claimed that most normal, 3- to 5-year-olds do not understand these sentences appropriately. Since Amidon and Carey established that the children were familiar with concepts of temporal sequence (e.g., as expressed by words like first and last), the implication is that the structure of these adverbial clauses is beyond the scope of the child's grammar at this age.

However, the acting-out tasks employed in these studies were once again unnatural ones which ignored the presuppositional content of the test sentences. Felicitous usage of sentence (29) demands that the pushing of the blue car has already been contextually established by the hearer as an intended, or at least probable, future event; but this was not established in these experimental tasks. It is very likely, then, that these studies underestimated children's ability to comprehend temporal subordinate clauses. For example, Amidon and Carey reported that five and six year old children who were not given any feedback frequently failed to act out the action described in the subordinate clause. Johnson (1975) found that four and five year old children correctly acted out commands such as those in (30) only 51% of the time; again, the predominant error was failure to act out the action described in the subordinate clause.

(30) a. Push the car before you push the truck. (Before S1, S2)

b. After you push the motorcycle, push the bus. (After S1, S2)

c. Before you push the airplane, push the car. (Before S2, S1)

d. Push the truck after you push the helicopter. (After S2, S1)
Crain (1982) satisfied the presupposition of the subordinate clause by having the subordinate clause act correspond to an intended action by the subject, and observed a striking increase in children's performance. To satisfy the presupposition, children were asked, before each command, to choose a toy to push on the next trial. The child's intention to push a particular toy was incorporated into the command that was given on that trial. For instance, sentence (30d) could be used felicitously for a child who had expressed his intent to push the helicopter. Correct responses (i.e., responses in which both the main clause and subordinate clause action were performed, and in the correct order) were produced 82% of the time. Crain's interpretation of these results was that the children's improved performance was due to the satisfaction of the presupposition of the subordinate clause.

However, we now note that the results of that study are open to another interpretation. It may be that improved performance was not due specifically to the contextual appropriateness of the sentence, but to the fact that the child's task was simplified because he was provided with more advance information concerning what his task would be. In the act-out or 'do-what-I-say' paradigm applied to temporal terms, the child must discern two aspects of the command: (i) which two toys to move, and (ii) in which order to move them. If the child has established his intent to move a particular toy, his task involving (i) is simplified. Thus, improved performance may be due to the satisfaction of presuppositions or it may be due to the additional information the child possesses.

Another study was conducted to disentangle these two factors (Gorrell, Crain, & Fodor, 1989). In this study, there were four groups of subjects. One group, the Felicity Group (F), was given commands containing before and after with prior information about the subordinate clause action, just as in the previous experiment. A second group, the Information Group (I) received prior information about the main clause action; note that this does not satisfy the presupposition of the sentence. There was also a third group, the No Context Group (NC), who received no advance information at all, and a fourth group, the Felicity plus Information Group (FI), who received information over and above what would satisfy the felicity conditions since they chose both actions in advance. Consider, for example, a subject in the F group. He would be asked to choose a toy to push. If he chose the bus, for example, a typical command would be (31).

(31) Push the car before you push the bus.

On the other hand, a subject in the I group who had chosen the bus would be given the command (32).

(32) Push the bus before you push the car.

Fifty-six children participated in the study, ranging in age from 3;4 to 5;10 (mean 4;5). Each child was assigned to one of the four groups, which were of equal size and approximately matched for age. The 'game' equipment consisted of 6 toy vehicles arranged in a row on a table between the child and the experimenter. The stimulus set consisted of 12 commands spoken by the experimenter which the child was to act out. There were three sentences of each of the four types illustrated in (30) above. We were careful to balance order of choice with order of action and assignment to clause type.

The results showed a significant difference between the F and FI groups on one hand, and the I and NC groups on the other. Table 1 shows the percentages of correct responses, where a correct response consisted of performing both actions in the sequence specified by the sentence.

| Clause Information | Main Clause Information | mean
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>Subordinate</td>
<td>FI 80%</td>
<td>77%</td>
</tr>
<tr>
<td></td>
<td>F 74%</td>
<td></td>
</tr>
<tr>
<td>Clause Information</td>
<td>I 51%</td>
<td>55%</td>
</tr>
<tr>
<td></td>
<td>NC 59%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>mean 65%</td>
<td>66%</td>
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</tbody>
</table>

Note that the relevant factor is whether subordinate clause information was provided in advance. An analysis of variance confirmed that the mere amount of information provided makes no significant difference. The FI group performed better than the F group by only 6 percentage points, which does not approach statistical significance. And the I group performed just a little worse (non-significantly again) than the NC group.

Although our study was not specifically designed to assess age differences, we performed a post hoc breakdown of correct responses by two age groups: under 4;4, and 4;4 and over. The older group, as one would expect, performed somewhat
better than the younger group. What is perhaps most interesting is that the younger group appear to be even more sensitive than the older group to the proper contextual embedding of utterances.6 A breakdown of the types of errors that occurred reveals that the predominant errors are (i) acting out the main clause only, and (ii) reversing the correct order of the actions. As noted above for relative clause constructions, acting out the main clause only is a quite reasonable response given that the context failed to satisfy the subordinate clause presupposition. And in fact most of these errors were found in the I and NC groups.7 Reversals were the most frequent error type in the study though they constituted only 19% of all responses. These errors may reflect a genuine lack of comprehension of either the temporal terms or the relevant syntactic structure. However no child in either the F or FI groups produced a consistent response pattern which would indicate that this was the case, so it seems more likely that these errors were due primarily just to occasional inattention.

The main conclusion we draw from these results is that children, from a very young age, are indeed sensitive to the proper contextual embedding of language. Their performance is facilitated by satisfying the presuppositions of temporal subordinate clauses, and information which does not satisfy the presuppositions does not result in facilitation.

A secondary conclusion is that children do construct the appropriate syntactic structure for sentences with embedded clauses. If the children in our study had failed to distinguish main from subordinate clauses (e.g., by assigning a ‘flat’ conjunction-type structure to the experimenter’s commands), we would not expect to find the difference between the F and I groups we observed. Nor is it plausible to suggest that the children relied upon a structure-independent formula of ‘old information precedes new information.’ For example, for the F group, the new information was always in the main clause. If children were assuming that old information would be first, we would have expected relatively poor performance from the F group on sentences in which the main clause preceded the subordinate clause. In fact, no such effect was observed.

In sum: once again, the linguistic knowledge of young children, when freed of interfering influences, appears to be quite advanced. Adults have the ability to set aside contextual factors in an unnatural experimental situation, but children, with their more limited cognitive and social skills, apparently do not have this ability. Consequently, they are highly sensitive to pragmatic infelicities. And therefore their linguistic knowledge can be accurately appraised only by tests which include controls to insure that they are not penalized by their knowledge of pragmatic principles.

2.3. Plans
Another possible source of poor performance by children is in formulating the action plans which are needed in order to obey an imperative, or act out the content of a declarative sentence which they have successfully processed and understood. As we use the term, a plan is a mental representation used to guide action. A plan may be simple in structure, consisting of just a list of actions to be performed in sequence; or it may be internally complex, with loops and branches and other such structures now familiar in computer programs.

Formulating a plan is a skill that makes demands on memory and computational resources. In certain experimental tasks, these demands may outweigh those of the purely linguistic processing aspects of the task. So when children perform poorly, it is important to consider the possibility that formulating, storing or executing the relevant action plan is the source of the problem, rather than imperfect knowledge of the linguistic rules or an inability to apply them in parsing the sentence at hand.

2.3.1. Prenominal Modifiers. The first study on plans that we conducted was in response to the claim by Matthei (1982) and Roeper (1972) that 4- to 6-year-olds have difficulty in interpreting phrases such as (33) containing both an ordinal and a descriptive adjective.

(33) the second striped ball

Confronted with an array such as (34), many children selected item (ii), i.e., the ball which is second in the array and also is striped, rather than item (iv) which is the second of the striped balls (counting from the left as the children were trained to do).

(34) Array for “the second striped ball”
Hamburger and Crain found that the children consistently responded to the second instruction by pointing to (v) rather than (iv), showing that they took the proform *one* to corefer with expressions like *striped ball*. Thus it appears that they do know the structure (35).

Finally, we note two experiments by Hamburger and Crain (1987). The purpose of these experiments was to provide empirical support for our claim that response planning is an important factor in psycholinguistic tasks, independently of syntax and semantics.

The empirical finding, then, appears to be that children assign an interpretation that is not the same as an adult would assign to expressions of this kind. This difference is attributed by Matthei to children's failure to adopt the hierarchical phrase structure internal to a noun phrase that characterizes the adult grammar. This structure is shown in (35). Instead, Matthei argues that children adopt a 'flat structure' for phrases of this kind, with both the ordinal and the descriptive adjective modifying the noun directly as in (36).

Hamburger and Crain also found quite direct evidence that children do not assign the 'flat structure' analysis. The standard assumption in linguistics is that proforms corefer with a syntactic constituent. In the correct structure (35), the words *striped* and *ball* form a complete constituent, but in the incorrect structure (36) they do not. Thus the children should permit the proform *one* to corefer with *striped ball* only if they have the correct hierarchical structure. To find out whether they permit this coreference, they were tested on the instructions in (37), with the array in (38).

Hamburger and Crain found that the children consistently responded to the second instruction by pointing to (v) rather than (iv), showing that they took the proform *one* to corefer with expressions like *striped ball*. Thus it appears that they do know the structure (35).

Finally, we note two experiments by Hamburger and Crain (1987). The purpose of these experiments was to provide empirical support for our claim that response planning is an important factor in psycholinguistic tasks, independently of syntax and semantics.

The first experiment attempts to show that children's ability to comprehend a phrase is inversely related to the complexity of the associated plan. For this purpose we compare phrases that are arguably equal to each other in syntactic complexity but differ in plan complexity. Examples are shown in (39), in increasing order of complexity of plans.

(39)  
1. John's biggest book  
2. second green book  
3. second biggest book  
4. biggest second book  
5. biggest book second
Planning complexity can also be deconfounded from the complexity of semantic constituent processing. Note that semantic considerations lead to the prediction that (39i), would be hardest, because its word meanings have to combine in a way contrary to the surface sequence of words (= the biggest of John's books).

The pattern of children's responses supports the predictions of our procedural account, and does not conform to the account based on syntactic or semantic constituency. Children responded correctly to phrases like (39ii) 88% of the time. They gave correct answers only 39% of the time for examples like (39iii), and they were only 17% correct for phrase like (39iii). Thus, this experiment provides clear evidence that plans, not linguistic structures (syntactic or semantic) can determine processing success and failure for young children.

The second experiment addresses the cognitive difficulty of planning by preacing the test with a sequence of exercises designed to alleviate the planning difficulty. This activity does not provide any extra exposure to the phrases tested; nevertheless, we anticipate a reduction in errors on these phrases. Consider a phrase such as “the second tallest building.” This plan requires the interpreter to identify its referent. The child must integrate sequential pairwise comparisons of relative size. In the pre-test activity the child would be shown a display of several objects of one type (say boxes), but of different sizes, and asked to hand the experimenter the biggest one. Then, once this object was removed from the array, the experimenter asked the child to perform the task again, saying, “Now, find the biggest box in this group.” In this way the child would identify the second biggest box without ever hearing the phrase “the second biggest box” uttered. Children's comprehension of the phrase was tested before and after the preparatory task. They gave significantly more correct responses (46%) following the preparatory task than before it (8% in this experiment). This result suggests that their difficulty with phrases of this sort stems from the complexity of the response plans.

3. SENTENCE PRODUCTION

To acquire a language is to learn a mapping between potential utterances and associated potential meanings. Successful mastery should reveal itself in both comprehension and production. In the previous section we were concerned with studies of children's comprehension, in which their knowledge is tested by presenting utterances and observing the interpretations that they assign. We now turn to tests of children's competence which proceed in the other direction: the input to the child is a situation, which has been designed to suggest a unique sentence meaning, and the behavior we observe is the utterance by which the child describes that situation.

It would have been reasonable to expect that the sorts of nonsyntactic problems that present obstacles for children in comprehension tasks might prove to be as hard or even harder for them to overcome in production tasks. But we have not found this to be the case. The results of recent elicited production studies are dramatically better than those of comprehension studies directed to the same linguistic constructions. For example, Richards (1976) elicited appropriate uses of the deictic verbs come and go from children age 4;0 - 7;7, while Clark and Garnica (1974) reported that even 8-year-olds didn't consistently distinguish between come and go in a comprehension task.

The disparity between production and comprehension studies is particularly striking because it is the reverse of what one would expect. To find production superior to comprehension in children's language is as surprising as it would be to find production superior to comprehension in adult second-language learning, or to find recall superior to recognition in any psychological domain. It is plausible to argue, therefore, that the superiority of production is only apparent, and is due to differences in the sensitivities of production tests and comprehension tests. And the logic of the situation suggests that it is the comprehension tests that are deficient. After all, success is hard to argue with. With suitable controls, successful production by children is a strong indicator of underlying linguistic competence, as long as their productions are as appropriate and closely attuned to the context as adult utterances are. Because there are so many ways to combine words incorrectly, consistently correct combinations in the appropriate contexts are not likely to come about by accident. On the other hand, failure on any kind of psychological task cannot be secure evidence of lack of the relevant knowledge, since the knowledge may be present but imperfectly exploited.

As we saw in the previous section, comprehension studies seem to be particularly susceptible to problems of parsing, planning and so forth which impede the full exploitation of linguistic knowledge. Production tasks appear to be less hampered by these extra-grammatical
factors. This is probably because production avoids non-verbal response planning, which we have seen is a major source of difficulty in act-out comprehension tasks. It is worth noting also that in constructing contexts to elicit particular utterance types, we have no choice but to attend to the satisfaction of the presuppositions that are associated with the syntactic structures in question, because otherwise the subjects won't utter anything like the construction that is being targeted. In elicited production it is delicate manipulations of the communicative situation that give one control over the subject's utterances.

3.1. Relative Clauses. In section 2 we presented evidence of young children's competence with relative clauses. Further confirmation was obtained by Hamburger and Crain (1982), using an elicited production methodology. Pragmatic contexts were constructed in which the presuppositions of restrictive relatives were satisfied. It was discovered that children as young as three reliably produce relative clauses in these contexts.

A context that is uniquely felicitous for a relative clause is one which requires the speaker to identify to an observer which of two objects to perform some action on. In our experiment, the observer is blindfolded during identification of a toy, so the child cannot identify it to the observer merely by pointing to it or saying this/that one. Also, the differentiating property of the relevant toy is not one that can be encoded merely with a noun (e.g., the guard) or a prenominal adjective (e.g., the big guard) or a prepositional phrase (e.g., the guard with the gun), but involves a more complex state or action (e.g., the guard that is shooting Darth Vader). Young children reliably produce meaningful utterances with relative clauses when these felicity conditions are met. For example:

(40) Jabba, please come over to point to the one that's asleep. (3;5)
    Point to the one that's standing up. (3;9)
    Point to the guy who's going to get killed. (3;9)
    Point to the kangaroo that's eating the strawberry ice cream. (3;11)

Note that the possibility of imitation is excluded because the experimenter takes care not to use any relative clause constructions in the elicitation situation. This technique has now been extended to younger children (as young as 2;8), and to the elicitation of a wider array of relative clause constructions, including relatives with object gaps (e.g., the guard that Princess Leia is standing on).

3.2. Passives. Borer and Wexler (1987) have argued that A-chains, which are involved in the derivation of verbal passive constructions, are not available to children in the first few years. Borer and Wexler maintain that knowledge of A-chains is innate, but becomes accessible only after the language faculty undergoes maturational change. We were not convinced, however, that this maturation hypothesis is necessitated by the facts. Rather, the facts seem to be consistent with A-chains being innate and accessible from the outset.

One source of data cited in support of the maturation hypothesis is the absence of full passives in the spontaneous speech of young children. But this of course is not incontrovertible evidence that children's grammars are incapable of generating passives. Full passives are rarely observed in adults' spontaneous speech either, or in adult speech to children. But their paucity is not interpreted in this case as revealing a lack of grammatical knowledge. Instead, it is understood as due to the fact that the passive is a marked form which it is appropriate to use only in certain discourse contexts; in most contexts the active is acceptable and more natural, or a reduced passive without a by-phrase is sufficient. That is, the absence of full verbal passives in adult speech is assumed to be a consequence of the fact that it's only in rare situations that the full passive is uniquely felicitous. But the same logic that explains why adults produce so few full passives may apply equally to children. Perhaps they too have knowledge of this construction, but do not use it except where the communicative situation is appropriate.

We have tested this possibility in an experiment with thirty-two 3- and 4-year-old children. (Crain, Thornton, & Murasugi, 1987). One experimenter asked the child to pose questions to another experimenter. The pragmatic context was carefully controlled so that questions containing a full verbal passive would be fully appropriate. The following protocol illustrates the elicitation technique:

Adult: See, the Incredible Hulk is hitting one of the soldiers. Look over here. Darth Vader goes over and hits a soldier. So Darth Vader is also hitting one of the soldiers. Ask Keiko which one.

Child to Keiko: Which soldier is getting hit by Darth Vader?
Note that the child knows what the correct answer is to his question, and that he cannot expect to elicit this answer from his interlocutor (Keiko) unless he includes the *by*-phrase. In fact, exactly 50% of responses were passives with full *by*-phrases. Of course, active constructions are also felicitous in this context (e.g., *Which soldier is Darth Vader hitting?*), even though the contextual contrast with another agent (the Incredible Hulk) may tend to favor the passive stylistically. And indeed 31% of responses were active questions with object gaps. The other 19% of responses included mostly sentences that were grammatical but not as specific as the context demanded (e.g., passive lacking *by*-phrases).

Using this technique, we were able to elicit full verbal passives from all but three of the thirty-two children tested so far, including ones as young as 3;4. Some examples are shown in (41).

(41) She got knocked down by the Smurfie. (3;4)
    Which girl is pushing, getting pushed by a car? (3;8)
    He got picked up from her. (3;11)
    It's getting ate up from Luke Skywalker. (4;0)
    Which giraffe gets huggen by Grover? (4;9)

Note that these utterances contain a variety of morphological and other errors, but they all nevertheless exhibit the essential passive structure (underlying subject in pre-verbal position; agent in post-verbal prepositional phrase). It might be argued that the children's passives elicited in this experiment do not involve true A-chains. However, since they are just like adult passives (disregarding morphological errors), the burden of proof falls on anyone who holds that adult passives involve A-chains and children's passives do not. No criterion has been proposed, as far as we know, which distinguishes adult's and children's passives in this respect. For example, it is true that the children almost always use a form of *get* in place of the passive auxiliary *be*, but *get* is acceptable in adult passives also. (*Get* is more regular and phonologically more prominent than forms of *be*, and this may be why it is more salient for children.)

Children's considerable success in producing passive sentences appropriate to the circumstances (i.e., their correct pairing of sentence forms and meanings) constitutes compelling evidence of their grammatical competence with this construction. Comparison of these results with the results of testing the same children with two comprehension paradigms (act-out and picture-verification) confirms that, like spontaneous production data, these measures underestimate children's linguistic knowledge.

The finding that young children evince mastery of the passive obviates the need to appeal to maturation to account for its absence in early child language. Maturation cannot of course be absolutely excluded; but a maturation account is motivated only where a construction is acquired surprisingly late—where this means later than would be expected on the basis of processing complexity, pragmatic usefulness in children's discourse, and so forth. (Also, as noted in section 1, some important cross-language and cross-construction correlations need to be established to confirm a maturational approach; see Borer & Wexler, 1987, on comparison of English passives with passive and causative constructions in Hebrew.) The elicited production results suggest that the age at which passive is acquired in English falls well within a time span that is compatible with these other factors, and so maturation does not need to be invoked.

3.3. *Wanna* contraction. Another phenomenon that can be shown by elicitation to appear quite early in acquisition is *wanna* contraction in English. The facts are shown in (42) and (43).

(42)a. Who do you want to help?
    b. Who do you *wanna* help?

(43)a. Who do you want to help you?
    b. Who do you *wanna* help you?

Every adult is (implicitly) aware that contraction is admissible in (42b) but not (43b). However, on the usual assumption that children do not have access to 'negative data' (i.e., are not informed of which sentences are ungrammatical) it is difficult to see how this knowledge about the ungrammaticality of sentences like (43b) could be acquired from experience (at any age). So this is yet another candidate for innate linguistic knowledge. (What is known innately would be that a trace between two words prevents them from contracting together. The relevant difference between (42b) and (43b) is that in (43b) the *who* is the subject of the subordinate clause and has been moved from a position between the *want* and the *to*. The trace of this noun phrase that is left behind blocks the contraction. In (42b), by contrast, the trace is in object position after *help*, and therefore is not in the way of the contraction.)

Crain and Thornton (in press) used the elicited production technique to encourage children to ask questions that would reveal violations like (43b) if
these were compatible with their grammars. The target productions were evoked by having children pose questions to a rat who was too timid to talk to grown-ups. The details of the procedure are illustrated in the following scenarios:

**Protocol for Object Extraction**


Child: What do you wanna eat?

**Protocol for Subject Extraction**

Experimenter: One of these guys gets to take a walk, one gets to take a nap, and one gets to eat a cookie. So one gets to eat a cookie, right? Ask Ratty who he wants.

Child: Who do you want to eat the cookie?

Using this technique, questions involving both subject and object extraction were elicited from 21 children, who ranged in age from 2;10 to 5;5, with an average age of 4;3. The preliminary findings of the experiment are clearly in accord with the expectations of the innateness hypothesis, although we must verify our own subjective assessment of these data using a panel of judges.10 In producing object extraction questions (which permit contraction in the adult grammar), children gave contracted forms 59% of the time and uncontracted forms 18% of the time. (There were 23% of other responses not of the target form, such as What can you eat to see in the dark?) By contrast, children’s production of subject extraction questions (where contraction is illicit) contained contracted forms only 4% of the time and uncontracted forms 67% of the time (with 29% of other responses).

The systematic control of this subtle contrast could perhaps have been shown on the basis of spontaneous production data, but the crucial situations (particularly those that call for subject extraction questions) probably occur quite rarely in children’s experience, just as they do in the case of the full passive. So it is not easy to gather data in sufficient quantity for statistical analysis. By contrast, the elicitation technique is obviously an efficient way of generating data, and thus facilitates testing for early acquisition of a variety of constructions relevant to the innateness hypothesis.

4. CONCLUSION

In this paper, we have reviewed a great many empirical studies. The thread that ties them together is the idea that, when performance problems are minimized in testing situations, children show early knowledge of a wide range of basic constructions. As early as 1965, Bellugi suggested that children’s errors on Wh-questions were due, not to a lack of knowledge of the two relevant transformations (Wh-movement and Subject/Auxiliary Inversion), but to a not yet fully developed capacity to apply both rules in the same sentence derivation. Our work extends this general idea to a broader set of linguistic phenomena. Our particular emphasis has been constructions which linguistic theory predicts should require little or no learning because they involve principles which are universal and hence innate. Our findings suggest that the innateness hypothesis for language is still secure even in its simplest form (in which different innate principles are not timed to mature at different developmental stages). Maturation of nonlinguistic abilities appears to be sufficient to account for the time course of linguistic development.

**REFERENCES**


**FOOTNOTES**


2. Also University of Connecticut, Storrs.

3. Also Graduate Center, City University of New York.

4. Susan Carey has pointed out (Boston University Conference, 1988) that the linguistic maturation hypothesis predicts that knowledge of a linguistic principle should correlate with gestation age rather than with birth age in children born prematurely. Unfortunately, variability is probably such that no clear correlation could be expected to show itself by age 4 or 5, when passives and other relevant syntactic constructions are claimed to emerge.

5. For full details of procedure and results of this experiment, and of all other studies reported in this paper, we refer readers to the original publications.

6. As far as is known at present, no natural language exhibits this blanket prohibition against backward pronominalization; see discussion in Lansik and Crain (1983). This suggests that it is not a possible constraint in a natural language grammar, in which case it should not be entertained by children at any age or stage of acquisition (unless one assumes linguistic maturation).

7. The awkwardness of the prosodic contour for (18), with its heavy juncture before the final word, may indicate that this kind of construction is also an unnatural one for the sentence production routines.

8. In reviewing the literature on relative clauses, de Villiers and de Villiers (1986) suggest that if earlier work had counted the assertion-only response as correct, children would have been seen to perform better there too. This objection is unwarranted, for two reasons. First, responses of this type did not appear in other studies, presumably because these studies failed to meet the presuppositions of the restrictive relative clause. More important, in the Hamburger and Crain study this response was not evinced by any of the 3-year-old children, and accounted for only 13% of the responses of the 4-year-olds. Nevertheless, even the 3-year-olds acted out sentences with relative clauses at a much higher rate (69%) of success than in earlier studies.

9. These results should be interpreted with caution due to the small and unequal number of subjects in each subgroup leading to rather uneven data. For example, the older F group performed relatively poorly compared to the younger F group,
though closer analysis reveals that this is due to the poor performance of just one child (4;4) in the F group.

7 There were no main-clause-only errors in the Fl group. For the F group, 12 of the 16 main-clause-only errors (out of 168 responses) are due to one child.

8 An A-chain is the association of a trace with a moved noun phrase in an A-position (= argument position such as Subject). For example, in The bagel was eaten by Bill there is an A-chain consisting of the bagel and its associated trace after eaten.

9 The proper reversal of underlying subject and object order occurred even when the task was complicated by an implausible scene to be described. For example, the sentence One dinosaur's being eaten from the ice cream cone was used to describe a situation in which the dinosaur was indeed being eaten by the ice cream, not vice versa.

10 In preliminary evaluation of the audio tapes, we have found it unexpectedly easy to distinguish children's contracted and non-contracted forms in most cases.