Structure Dependence in Grammar Formation
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STRUCTURE DEPENDENCE IN GRAMMAR FORMATION

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A fundamental goal of linguistic theory is to account for language acquisition. At the heart of the problem is the poverty of the stimulus, which underdetermines the hypotheses that children formulate. Generative grammar proposes that the form for expressing rules is innately constrained, and one putative constraint is structure-dependence. The present study subjected this proposal to an empirical test. In the first experiment, yes/no questions—amenable in principle to both structure-dependent and structure-independent analyses—were elicited from thirty 3- to 5-year-old children. A second experiment explored the nature of children's errors in Experiment 1. A third experiment contrasted a structurally-based account of the acquisition of interrogatives with one based on semantic generalization. The results of these experiments support Chomsky's contention that children unerringly hypothesize structure-dependent rules. Moreover, it was found that the rules which children invoke are formally insensitive to the semantic properties of noun phrases—a finding that supports the developmental autonomy of syntax.*

Noam Chomsky's theory of Universal Grammar (1971) maintains that children invariantly apply structure-dependent hypotheses in the course of language acquisition, eschewing structure-independent hypotheses even when many of the available data are consistent with hypotheses of either type. Roughly, a structure-dependent operation is one which is based on the abstract structural organizations of word sequences.[1] By contrast, structure-independent operations apply to sequences of words themselves, and include operations like NEXT and CLOSEST which are contingent on linear order.[2] Chomsky (1971:28) accords structure-dependence the status of an 'innate schematism applied by the mind to the data of experience'. This paper presents two experiments designed to test this claim. A third experiment focuses on the developmental autonomy of syntax, a view that contrasts sharply with the widely held belief that semantic properties of sentences emerge first in grammar for-

[1] These structures are abstract in the sense that nothing marks their boundaries when we hear them. It is a common belief that syntactic boundaries are marked by intonational cues; and indeed, speakers do provide several phonetic cues which mark structural breaks when their productions are syntactically ambiguous (see Cooper & Paccia-Cooper 1980). However, these cues apparently have limited effect on listeners, who often fail to identify correctly the intended meaning (cf. Lehiste 1973, Wales & Toner 1979).

[2] To avoid confusion, we should distinguish between two notions of structure-independence. A rule can be considered structure-independent if (a) it is an operation on strings of words, rather than on their structural representations; or (b) it mentions only linear relations. A rule which satisfies both of these conditions is clearly structure-independent. The hypothesis of central concern in this paper (Hypothesis I, §2) is structure-independent in this strong sense. The status of other hypotheses is less clear (see the discussion on pronominalization in §1). For instance, rules may be considered structure-dependent if they apply linear operations to high-level structural representations, or if they mention structural relations (and perhaps also linear relations).

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mation and serve as the foundation for syntactic generalizations—i.e. the SE-MANTIC GENERALIZATION hypothesis of Stemmer 1981.

1. PREVIOUS RESEARCH ON STRUCTURE-DEPENDENCE. In view of its impor-tance, there have been surprisingly few experimental investigations of struc-ture-dependence. We know of only two phenomena which have been investigated. First, a study of children's implicit awareness of constituent struc-ture was done by Read & Schreiber 1982, in which 7- and 8-year-olds tried to mimic the way one experimenter repeated back fragments of another experi-menter's sentences. In one condition, major phrasal constituents were repeated (i.e. subject NP's and predicate phrases). In a second condition, four-unit se-quences (words or syllables) were repeated. After a demonstration period, the child took the place of the ECHOING experimenter for about 15 trials with feed-back, and the investigators noted the number of trials required for a child to give consistently correct responses. Not a single child was able to correctly repeat the NON-CONSTITUENT fragments as many as 4 times consecutively, but over half of the children achieved this level of success when the fragments formed syntactic constituents. Thus a structure-independent operation on word strings proved extremely difficult for children on this metalinguistic task. It is plausible to suppose that they performed significantly better because they could rely on their implicit knowledge of constituent structure.

A series of experiments on pronominalization also bears on the nature of children's grammatical hypotheses. It is important to note that, even if a sen-tence is assigned constituent structure, structure-independent operations can be performed on these constituents. It has been proposed that one such op-eration is present in children's early grammars. The claim is that young children rule out coreference between a pronoun and a noun phrase just in case the pronoun appears first in a sentence (cf. Solan 1983). This prohibition would be structure-independent in the sense that it is based on the linear order of con-stituents—not on their structural relationships as in adult grammar, where co-reference is precluded only if the pronoun c-commands the NP.

Tavakolian 1978 is often cited as evidence of children's linear restriction on backwards pronominalization. An object manipulation paradigm was used by Tavakolian to assess the grammatical knowledge of 3- to 5-year-olds. In this task, the experimenter first presents a sentence; then the child acts out its meaning, using toy animals and other props available in the experimental work-space. It was found that children often selected an animal not mentioned, but present in the workspace, as the referent of the pronoun in sentences like these:

    (1) For him to kiss the lion would make the duck happy.
    (2) That he kissed the lion made the duck happy.

Solan (83–4) concludes from these results that 'children use direction rather than structural principles in restricting anaphora' in such cases.

This conclusion is unwarranted, as has been pointed out by Hamburger & Crain 1984, Lasnik & Crain 1985. For ambiguous sentences like 1–2, the object manipulation task forces children to select among competing interpretations; hence their proclivity to act out the extrasentential interpretation of the pronoun

is, at most, evidence of a preference for this reading over the other. These responses do not necessarily reflect a grammatical prohibition against backwards anaphora.

The availability of the backwards anaphora reading for preschool children was investigated by Crain & McKee 1985. The crucial methodological innovation here was the development of a task which allows children to demonstrate their knowledge of all the interpretations of an ambiguous sentence. The subjects judged the truth value of sentences like the following against situations acted out by the experimenter:

    (3) When he took the chickens, the lion was in the box.
    (4) He took the chickens when the lion was in the box.

Children who accept backwards pronominalization should judge 3 to be true if the lion took the chickens when he was in the box. They should also judge this sentence to be true when someone else took the chickens, where the extrasentential interpretation of the pronoun could be assigned. This is exactly what was found. Sixty-two children, 2 to 5 years old, judged sentences like 3 to be true almost equally often whether the lion (73%) or someone else (81%) had taken the chickens when the lion was in the box. In contrast, sentences like 4 were judged to be FALSE 88% of the time (for this example, the lion had taken the chickens). The findings indicate that even 2- and 3-year-olds prohibit backwards anaphora only when structural conditions like c-command dictate, as in the adult grammar; they do not adhere to a restriction based solely on linear order.[3]

We conclude that previous research supports the contention that children's grammatical hypotheses adhere to structure-dependent principles. However, no critical experiment has been reported up to now. This paper explores children's grammatical hypotheses in connection with the 'movement transformation' which Chomsky has discussed in a number of papers (1968, 1971, 1975, 1986), namely subject/AUX inversion in sentences with relative clauses. What makes this case especially intriguing is the fact that both structure-dependent and structure-independent hypotheses are consistent with a portion of the primary linguistic data.

    2. TWO HYPOTHESES ABOUT YES/NO QUESTIONS. The linguistic phenomenon of concern here is the formation of yes/no questions. The format for our state-

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[3] A third set of experiments concerned with 'control' phenomena should also be mentioned. In an early study, C. Chomsky 1969 found that school-age children frequently misinterpreted subject-control sentences like this:

    (a) Bozo promises Donald to do a somersault.

She suggested that these misinterpretations reflect a M[inimum] D[istance] P[rinciple] which makes explicit mention of structural notions, viz. NOUN PHRASE and SUBJECT of a complement verb. Given this formulation, the MDP is structure-dependent, despite the use of precedence. In any event, the MDP does not provide an adequate account of children's interpretations of missing complement subjects: subsequent research of Maratsos 1974 and Goodluck 1981 found that preschool children correctly interpret passivized object control sentences like (b)–(c), which they ought to misinterpret if they were abiding by the MDP:

    (b) The bear is told by the elephant to get in.
    (c) The boy is told by the girl to jump over the fence.

ment of the problem is adapted from Chomsky 1971. First, a structure-independent account of yes/no questions is given, followed by a structure-dependent formulation. Then two accounts of the acquisition of yes/no questions are developed, with special attention to their different empirical consequences. In §3, we present an experiment designed to test between the two acquisition scenarios.

To begin, consider how the simple declarative sentences 5a–c might be related to their question counterparts:

(5) a. The man is tall.   Is the man tall?
    b. The book is on the table.   Is the book on the table?
    c. I can go.   Can I go?

On this evidence alone, the relation between the declarative and question forms seems to be captured by the following statement:

Hypothesis I: In yes/no questions, the leftmost verbal element of a declarative (*is, can* etc.) has been moved to the front of the sentence.

This hypothesis is structure-independent because it ignores the higher-order structural units of sentences.[4] It works with simple sentences like 5a–c; however, it gives incorrect results for more complex sentences like this:

(6) The man who is tall is in the other room.

In this case, Hypothesis I would result in the ungrammatical question 7 instead of the correct 8:

(7) *Is the man who ＿＿＿ tall is in the other room?
(8) Is the man who is tall ＿＿＿ in the other room?

What went wrong in creating the question counterpart to 6? The problem is that the leftmost verbal element *is* occurs in the relative clause *who is tall*. But verbal elements inside relative clauses are not affected in forming yes/no questions, as the ungrammatical 7 illustrates. Hypothesis I thus fails, despite its simplicity and initial plausibility. Its lack of generality is at once apparent when the data to be accounted for are extended to include more complex sentences.

As Chomsky points out, only a hypothesis which recognizes the internal structure of sentences produces the right results for both simple and complex cases. The formation of yes/no questions requires a structural analysis of a sentence into phrasal structures like NOUN PHRASE and VERB PHRASE, as well as into different levels of structure like MAIN CLAUSE and SUBORDINATE CLAUSE. Types of clauses must be kept distinct because (as we saw) main clauses can be affected by certain transformations, but relative clauses cannot. What is

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[4] Other structure-independent hypotheses might also be framed by children in response to sentences like 5a–c. For instance, they might decide that the rightmost verbal element of declaratives is moved to the front to create corresponding yes/no question forms. It is interesting to note that this hypothesis would result in the correct question counterpart to ex. 6, viz. ex. 8. So this alternative hypothesis would succeed in some instances where Hypothesis I fails. In other cases, however, this hypothesis would produce incorrect question forms. For instance, for the sentence *The dog is chasing the cat that is running*, the corresponding question form would be **Is the dog is chasing the cat that running?* Our data are sufficient to rule out this hypothesis, since an embedded question of precisely this kind was included in Experiment 1. For expository reasons, the data are presented in fn. 7.

needed is a structure-dependent hypothesis, roughly as follows, which turns on the notions MAIN CLAUSE and SUBJECT:[5]

Hypothesis II: In yes/no questions, the auxiliary verb in the main clause of a declarative is inverted with the subject noun phrase.

This hypothesis does not apply to a sentence construed as a linear string of words, but rather to abstract structures in which words appear as the terminal symbols. With these structures in hand, the correct question form corresponding to 6 can be generated, namely ex. 8. In 8, the *is* which appears at the front would have originated immediately following the entire Subject NP (*the man who is tall*). Hypothesis II, then, produces correct yes/no question forms for both simple and complex cases. Hypothesis I makes the right predictions only for simple sentences.

It seems reasonable to suppose that children encounter the simpler forms first. Since the structure-independent operation appears to be computationally simpler than Hypothesis II (cf. Chomsky 1971:27) and since it is consistent with this subset of primary linguistic data, one might suppose that at least some children entertain Hypothesis I during grammatical development, contrary to the claims of Universal Grammar. These children would produce ungrammatical questions like 7 when they first attempt to form yes/no questions with complex Subject NP's. This possibility is explored in Experiment 1, presented in §3 below.

Apart from the question of fact, there is a problem with this scenario. It is generally held that adults do not inform children when they have committed grammatical errors. Syntactic misgeneralizations in the absence of such NEGATIVE DATA raise a serious question for learnability: how would children learn that an error had occurred, and so correct the error? At the same time, when misgeneralizations do occur, they apparently reside in children's grammars for some time before they are abandoned in favor of correct generalizations. For example, overgeneration of lexico-syntactic phenomena such as causative verbs (*Who deaded my kitty cat?*) has been observed to begin at age 3, and to continue at least until age 7 (cf. Bowerman 1974). There is some reason to expect, then, that 'pure' SYNTACTIC misgeneralizations (e.g. subject/AUX inversion) would also persist through early childhood, should they arise. It is

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[5] Another possible account of yes/no question formation has been pointed out to us by Steven Pinker. This account takes advantage of the fact that structural embeddedness is often confounded with discourse backgrounding. The relevant observation is that relative clauses often contain 'given' or 'presupposed' information. In every case we discuss in this paper, a principle such as 'Avoid movement out of clauses which bear presuppositions' would make the same predictions as the structure-dependent Hypothesis II. Though the present study provides no data to rule out this possible source of children's correct responses, sentences exist which could tease apart the alternatives. For example, sentences in which the head of the relative clause contains a quantifier do not necessarily have presuppositional content: *Every boy who is tall is taught to play basketball.* This sentence does not seem to presuppose that particular boys have been introduced in the discourse, so the discourse-based hypothesis would not apply in this case. We would guess, however, that young children can correctly form yes/no questions corresponding to such sentences.

Further research is needed to rule out alternatives such as this. To our knowledge, the only serious contender that has actually been proposed is the 'semantic generalization' account investigated in Experiment 3.

also pertinent to note that, even when adults point out these errors, children normally seem to pay no attention to them (cf. McNeill 1966).

Are there POSITIVE DATA which would justify the abandonment of the structure-independent rule? Complex questions like 8 are the obvious candidates: these demand a structure-dependent rule, which in turn could also be used to produce the simpler question forms. The problem is that the structure-dependent rule could simply be ADDED to children's grammars; such addition would not necessarily prompt the abandonment of the old rule. The expansion of primary linguistic data to include sentences like 8 would be evidence, at most, of an alternative way to ask yes/no questions. If so, children might continue to produce ungrammatical utterances, e.g. 7, as well as correct forms like 8. So the problem of UNLEARNING is not resolved by appeal to positive data, without some additional provision such as Wexler's Uniqueness Principle (1979).[6]

The theory of U[niversal] G[rammar] circumvents the problem of unlearning altogether. According to UG, children do not entertain structure-independent rules, even when relevant evidence is consistent with such rules; hence syntactic misgeneralizations and their ungrammatical progeny, such as 7, are avoided altogether. By the alternative acquisition scenario of UG, children's first attempts to form complex yes/no questions would invoke the structure-dependent Hypothesis II, regardless of its computational complexity as compared to the structure-independent Hypothesis I. The following experiment was designed to find out which of these two possibilities is closer to the truth.

3. EXPERIMENT 1: ELICITING COMPLEX YES/NO QUESTIONS. This experiment elicited productions of yes/no questions from children 3 to 5 years old—well within the age range at which subjects have been observed to commit overgeneralizations. As we will see, however, children in this age range seem to have a productive rule of subject/AUX inversion. We elicited yes/no questions in this study to determine whether the rule which children have formulated conforms best to the structure-independent Hypothesis I or the structure-dependent Hypothesis II.

The yes/no questions that were elicited corresponded to complex declarative sentences—i.e., ones containing a relative clause in the subject noun phrase, as in 6. Thus children were required to apply their grammatical knowledge to the task of generating yes/no questions which they might not have attempted before, and ones which were contrived to be amenable in principle to either structure-independent or structure-dependent rules.

The experimental technique is similar to that of Bellugi 1971. Her study was

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[6] To resolve such dilemmas, it has been suggested (cf. Wexler 1979) that transformational rules which duplicate surface strings can coexist only if (readily available) positive data exist for each rule. Otherwise, only the rule that is data-justified will persist. Such a uniqueness principle might be adapted in the present case to explain how children might abandon incorrect hypotheses like I. The principle would apply after the rule for generating complex questions was formulated, to force out the incorrect structure-independent hypothesis. However, S. Pinker has pointed out to us that there is no straightforward way to apply a uniqueness principle to syntactic rules. Fortunately, children don't need to unlearn the incorrect structure-independent rule; our experimental results show that unlearning is unnecessary.

designed to see if children performed subject/AUX inversion in WH-questions, but her sentences did not contain relative clauses. Elicitation experiments along similar lines have explored children's knowledge of other syntactic constructions (Crain 1982, Hamburger & Crain 1982, Tager-Flusberg 1982).

3.1. SUBJECTS. Thirty children, of mean age 4;7, participated in the experiment. They were divided by age into two groups of 15 each, for purposes of data analysis. The children in Group I ranged in age from 3;2 to 4;7 (mean 4;3). Children in Group II ranged in age from 4;7 to 5;11 (mean 5;3).

3.2. DESIGN AND PROCEDURE. The experimental task had each child pose questions to a doll (Jabba the Hutt, a figure from *Star Wars*) which was manipulated by one of the two experimenters. The other experimenter directed the child to ask Jabba particular questions about a set of pictures, which were then shown to Jabba. After each elicited question, Jabba was made to respond *Yes* or *No*. Whenever a question evoked an appropriate answer from Jabba, the child pretended to feed Jabba. All the children were enthusiastic participants in this game.

3.3. MATERIALS. The children's questions were elicited by requests from the experimenter; these contained embedded questions for which the children produced corresponding yes/no questions. The experimenter's embedded questions fit into the schema *Ask Jabba if* _____; e.g., *Ask Jabba if the boy who is watching Mickey Mouse is happy.*

Six questions were elicited from each child. All these corresponded to embedded questions which were amenable, in principle, to both structure-dependent and structure-independent operations. The embedded questions all contained subject relatives; and except for one sentence, all test sentences contained two occurrences of the auxiliary verb *is*, for simplicity (cf. §5.2, below). However, the relative clauses in the test sentences differed in several ways, as can be seen in the experimental materials. For example, test sentence 10b has a superficially empty object (OBJECT GAP), whereas 10e has a passivized relative clause with a subject gap. The syntactic features of these sentences were varied for two reasons: (a) to block the formation of a non-syntactic strategy for identifying their corresponding question forms; and (b) to provide both easy and difficult relative clauses to which the child could respond (we return to this point below). The experimental trials followed the elicitation of three pretest questions, which served to ensure that children understood the task and could form simple yes/no questions.[7] Both sets of sentences appear below in their order of presentation.

 (9) Pretest sentences
  a. The girl is tall.
  b. The man is tired.
  c. The pig next to the tree is red.
 (10) Test sentences (Subject relatives)
  a. The dog that is sleeping is on the blue bench.
  b. The ball that the girl is sitting on is big.
  c. The boy who is watching Mickey Mouse is happy.
  d. The boy who is unhappy is watching Mickey Mouse.
  e. The boy who is being kissed by his mother is happy.
  f. The boy who was holding the plate is crying.

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[7] One control sentence, *The big dog is scaring the cat that is shaking*, was also included in this experiment. This sentence introduced a degree of syntactic complexity beyond that of the pretest sentences; and it contains a relative clause modifying the OBJECT—not the SUBJECT, as in the test sentences of Experiment 1.

Out of the 28 responses to this sentence, 26 were grammatical. The ungrammatical responses were produced by two children who gave grammatical responses to the pretest sentences. Children's responses to the control sentence are not reported in the text, since this sentence could be converted into its correct yes/no question by application of either structure-dependent or structure-independent rules. These data are relevant to the discussion in fn. 4, since they provide further evidence that the presence of a relative clause in a sentence does not necessarily induce production errors.

Application of Hypothesis I results in ungrammatical question forms for sentences 10a–f. Thus the result of moving the first *is* to the front of 10a is the ungrammatical question *Is the dog that sleeping is on the blue bench?* These test sentences, then, allowed us to see whether children of this age form the correct structure-dependent rule or an incorrect, structure-independent rule.

The pictures associated with sentences bearing restrictive relative clauses were designed to satisfy the FELICITY CONDITIONS on the use of this linguistic construction (see Hamburger & Crain 1982). In particular, the pictures depicted two objects corresponding to the head of the NP that was modified by the relative; and one of these objects was appropriately described by the content of the relative clause. For example, the picture corresponding to 10a had two dogs in it; one dog was asleep (on a blue bench), and another one was standing up. Before asking a child to question Jabba about a picture, the experimenter pointed out the relevant figures and actions depicted in the picture for each trial.

3.4. RESULTS AND DISCUSSION. There were only 2 erroneous responses to the pretest sentences;[8] these were produced by 2 children from the younger group. This paucity of errors indicates that even the younger children in this study have adopted some version of a yes/no question rule. However, Table 1 shows that children did not completely master yes/no questions of the complexity of the test sentences. Of the total number of elicited responses, 40% were ungrammatical. For Group I, 62% of the responses were ungrammatical; for Group II, 20% were ungrammatical. This difference was significant ($F(1,28) = 25.10$; $p<.001$). At least the children in Group I, then, found it difficult to deal with some of the test sentences. These children seem to be appropriate subjects for investigating the prediction that grammar formation is limited to structure-dependent rules, by examining the nature of their errors. Any MISGENERALIZATION of the adult rule for forming yes/no questions should be attested in the productions of these children.

		GRAMMATICAL	UNGRAMMATICAL
Group I	81	31 (38%)	50 (62%)
Group II	87	70 (80%)	17 (20%)
Total	168	101 (60%)	67 (40%)

TABLE 1. Correct and incorrect responses by group.

A first look at children's errors by sentence type reveals that even children in Group I were probably not misgeneralizing. As Table 2 (overleaf) shows, a high proportion of ungrammatical responses to the experimental sentences was evoked in reply only to a subset of the test sentences. Children in Group I produced correct yes/no questions at least half of the time for three of the six test sentences, and they gave grammatical responses about two-thirds of the time for two of the test sentences (10a,d).

For the most part, children in Group II evinced the same pattern of errors by sentence type; but they produced far fewer ungrammatical utterances on any of the test sentences. Thus the statistical analysis revealed a main effect of test items ($F(5,128) = 4.71$; $p<.001$), but there was no group by item interaction. Children in Group II made fewer than 10% ungrammatical responses

[8] Out of the 90 pretest trials, children responded 67 times with yes/no questions. Most of their failures to respond occurred on the initial trial; only 17 out of 30 yes/no questions were elicited. Every child displayed understanding of the task on either the second or third trial, so no child was eliminated from further participation on the test trials.

SENTENCE	GROUP I	GROUP II	TOTAL
(10) a.	.62	.93	.78
b.	.50	.73	.62
c.	.20	.87	.53
d.	.67	.93	.81
e.	.20	.73	.47
f.	.17	.64	.42

TABLE 2. Proportion correct by sentence.

to 10a and 10d, indicating that even fairly complex yes/no questions (with relative clauses) are within the processing capabilities of children of this age group (see also fn. 7).

We consider next the variety of errors that children made, and the individual subject data. Our main finding was that no child produced an utterance in which a verbal element in a relative clause was MOVED. Although the children produced many ungrammatical utterances, they made no errors like 7 above that would specifically implicate Hypothesis I. This experiment, then, provides presumptive support for Chomsky's prediction that children never make such errors. Even though Hypothesis I is consistent with simple input (as exemplified by all the pretest sentences), it was never implemented in this study.

What errors did occur? Eighty-two percent of children's ungrammatical utterances contained errors of one of two types. First, some utterances contained an extra auxiliary verb (*Is the boy who is being kissed by his mother is happy?*); we refer to this as a Type I or 'prefix' error. Second, they sometimes followed a well-formed fragment of a question by a second question, containing a pro-form (*Is the boy that is watching Mickey Mouse, is he happy?*); this will be called a Type II or 'restarting' error. The restarting error has the look of a typical performance error by adults; hence this type does not appear relevant to the question of children's grammar formation rules. A Type III or structure-independent error is the kind of error that would have appeared if the children had adopted Hypothesis I (*Is the boy that watching Mickey Mouse is happy?*). A summary of the error data appears in Table 3, and a breakdown of errors by sentence type appears in Table 4.

	TOTAL	TYPE I	TYPE II	TYPE III
Group I	50 (62%)	30 (60%)	10 (20%)	0
Group II	17 (20%)	9 (53%)	5 (29%)	0
Total	67 (40%)	39 (58%)	15 (22%)	0

TABLE 3. Types of errors by group.

The distribution of errors by age suggests that children shift from Type I to II, with Type II characteristic of the older children. Fifteen children made Type I and 'other' errors, but no errors of Type II (mean age 4;5). Eight of these children made Type I errors only. Although four children in this category produced only one erroneous response, the other four children erred 60–80% of the time. Four children made errors of both Types I and II (mean age 4;7).

| | | TYPE I | | TYPE II | | OTHERS | | TOTAL ERROR |
Sentence	CORRECT RESPONSES	GI	GII	GI	GII	GI	GII	RESPONSES
4	21 (78%)	2	0	2	1	1	0	6
5	18 (62%)	3	3	3	1	1	0	11
6	16 (53%)	8	0	2	0	2	2	14
7	21 (81%)	3	1	1	0	0	0	5
8	14 (47%)	7	1	0	2	5	1	16
9	11 (42%)	7	4	2	1	1	0	15
Total	101	30	9	10	5	10	3	67

TABLE 4. Frequency of correct responses and errors by sentence and by group.

Three children made Type II and 'other' errors, but no Type I errors (mean age 4;11).[9]

Despite the absence of Type III errors, the Type I error data pose a new, unexpected threat to the claim that children adhere to structure-dependence in rule formation. Consider utterance 12, a Type I error given in response to the experimenter's request in 11:

(11) Ask Jabba if the boy who is watching Mickey Mouse is happy.

(12) Is the boy who's watching Mickey Mouse is happy?

Note that the auxiliary verb *is* which begins this child's question also appears both in the main clause and in the relative clause, although it has not been MOVED from either clause. There are two other ways it might have gotten there. First, it could have been copied from one of its occurrences in the experimenter's assertion. If it were copied from inside a relative clause, this would clearly be another kind of structure-independent error by children: it would be a case of infringement upon the structural integrity of the relative clause. The source of this error will be investigated in detail in Experiment 2 (§5, below).

There is a second possible source of the initial *is*: children might simply have inserted it into sentence-initial position, and then repeated the experimenter's assertion. It is not clear whether this error violates structure-dependence. Some languages attach question markers clause-externally, e.g. French *est-ce que* or Japanese *ka*. If children are adopting this as an early hypothesis about English, then their hypothesis differs fundamentally from a structure-dependent movement rule, but it is not a structure-independent rule.

Our next task is to identify the source of children's errors, whether they reflect a non-adult grammatical hypothesis about subject/AUX inversion—or, alternatively, are failures in performance, not competence. In the paragraphs that follow, we argue that that children's errors in response to some of the sentences in Experiment 1 reflect performance factors rather than lack of grammatical knowledge. Although the distinction between structural and processing

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[9] Six children made no errors (mean age = 5;3); two children made only errors of 'other' kinds (mean age = 4;5). Two children gave no correct responses at all. One of these children made two Type I errors and three 'other' responses; the other child made two Type I errors and two Type II errors, out of 4 responses.

deficits is difficult to draw, the research findings in the present case favor a processing explanation of children's Type I errors.

Two findings of Experiment 1 support a processing account. First, children in both groups made few errors of any type in response to a subset of the sentences, and they had nearly perfect performance on the pretest sentences. Since there are so many ways to make errors in production, and since the production errors that did appear were made in response to what look like the more complex cases, the most straightforward interpretation of the errors would seem to be in terms of processing. It seems reasonable to suppose, then, that children's correct productions demonstrate their grammatical competence. Second, there was no group by item interaction. This can be taken as evidence that the processing complexity of these test sentences, rather than children's lack of grammatical competence, was the source of their performance failures (for discussion, see Shankweiler & Crain 1986). If errors resulted from mis-generalizations of a rule, the fact that different children made the same pattern of errors across sentence types would be mysterious. The argument for a processing account of the errors is also bolstered by the near-perfect performance of an even younger group of children in Experiment 3, in response to other kinds of test sentences (see §7).

A follow-up study was conducted (Nakayama 1986) to test processing vs. structural explanations of children's errors in Experiment 1. This study was designed to identify the factors that impede children's performance in processing yes/no questions. Sixteen 3- to 5-year-olds participated in the study, which used the same experimental procedures as Experiment 1; but both sentence length and syntactic structure of the embedded questions were systematically varied. The findings were consistent with a performance explanation of children's errors. Specifically, children made significantly fewer errors in response to embedded questions with short relative clauses with intransitive verbs, as compared to long relative clauses with transitive verbs (66% vs. 45% correct). With length held constant, children had more difficulty in producing relative clauses with object gaps (41%) than ones with subject gaps (66%), although this effect was not quite significant (presumably because there were too few items). The ease of subject-gap as compared to object-gap constructions has been found in other studies in language development, in language-impaired populations, and in experiments on adult sentence processing (where the question of competence is not in doubt). The emergence of a similar pattern in the follow-up study constitutes further support for a processing explanation of children's production errors in Experiment 1.[10]

[10] Other evidence for a processing explanation was obtained in the study of Crain et al. 1986. In that study, relative clauses were elicited from a subset of 18 out of the children who participated in Experiment 1. Following procedures outlined in Hamburger & Crain 1982, these children were put in a series of situations in which subject-gap, object-gap, and passivized relatives were appropriate, but where alternative constructions (such as conjoined clauses) were infelicitous. Every child produced all three types of relative clause. It thus seems reasonable to assume that all the subjects in the present study were able to comprehend and produce relative clauses in declarative sentences. This in turn invites the inference that children's production failures in the present case did not result from inability to analyse relative clauses in embedded questions.

We have argued that children's errors in Experiment 1 are not misgeneralizations of the rule of subject/AUX inversion. We interpret the results of this experiment as support for Chomsky's contention that children hypothesize structure-dependent grammatical rules. The absence of Type III errors by these children favors the account of language acquisition given by UG—since, as predicted, some incorrect grammatical hypotheses are avoided, despite their being at least as simple and plausible as the correct hypothesis. In the next section, our focus turns from errors that didn't occur to ones that did. Specifically, we will consider the possibility that Type I or 'prefix' errors, which emerged with surprising regularity in this experiment, result from structure-independent processing.

4. STRUCTURE-DEPENDENCE IN CHILDREN'S PROCESSING. Some researchers have claimed that a movement transformation like subject/AUX inversion should not be treated as a monolithic syntactic entity, but rather as a composite of two more basic transformational operations which are executed independently (cf. Mayer et al. 1978). This movement is conducted in two parts: first, a copy of the constituent is inserted into a new location; then the source constituent is deleted. Copying and deletion are taken to be basic transformational operations. One important consequence of this BASIC OPERATIONS HYPOTHESIS is that it allows elementary transformations to be acquired independently. On this view, stages of language development may exist at which a child has mastered one but not the other component of movement. A wide range of errors that have been observed in child language have been interpreted as arising from early grammars that do not yet include rules to delete constituents after they have been copied. Errors that have received such an explanation include Tense-Hopping, Particle Movement, Dative Movement, and Subject/AUX Inversion; e.g.,

    (13) Tense-Hopping
        a. Did you came home?
        b. What did you got?
        c. I did broke it.
    (14) Particle Movement
           The barber cut off his hair off.
    (15) Dative Movement
           Could you get me a banana for me?
    (16) Subject/AUX Inversion
        a. Did you did came home?
        b. Whose is that is?
    (17) From Experiment I (Subject/AUX Inversion)
           Is the boy who is watching Mickey Mouse is happy?

In the present context, we shall reinterpret the Basic Operations Hypothesis as a model of performance; in this role, it provides an intriguing explanation of prefix errors like 17, which would be the result of copying but not deleting AUX. Moreover, children who make such errors could be performing a structure-independent operation of inserting, into sentence-initial position, a copy

of the *is* from a relative clause. Of course, if the *is* in a main clause were copied, this would be a structure-dependent error. The possibility of a structure-independent copying error arises when children attempt to form yes/no questions with subject-relative clauses, as in Experiment 1. The fact that both clauses in the test sentences contain the same AUX (except for test sentence 10f) makes it impossible to tell which AUX, if any, has been copied.

It is possible to tell which AUX has been copied in children's responses to embedded questions in which a different AUX appears in each clause. Sentences like 10f (repeated here as 18a) are crucial to determining which of our several hypotheses is correct:

    (18) a.   The boy who was holding the plate is crying.

         b.   *Was the boy who was holding the plate is crying?

No errors in response to 18a specifically implicated structure-independent processing; i.e., there were no responses like 18b.[11] For a number of reasons, however, we felt that this sentence did not reveal the nature of Type I errors. First, 10f was the only test sentence of its kind in Experiment 1; this means that too few data were available for drawing any firm conclusions. Second, this sentence may have been infected with whatever biases developed on earlier trials, which always contained the same AUX in both clauses. Finally, of all the test sentences, 10f evoked the fewest grammatical responses. For these reasons we decided to conduct a second, follow-up, experiment on the source of Type I errors, using more sentences like 10f—but with the modals *can* and *should*, rather than the past tense of the copula.

5. EXPERIMENT 2 was designed to discover the source of the prefix errors in Experiment 1. Three alternative procedures were considered:

    (19) To form a yes/no question from the experimenter's assertion, begin it with

        (S1) a copy of the LEFTMOST auxiliary verb;

        (S2) the copula *is*, followed by a replica of E's assertion;

        (S3) a copy of the auxiliary verb in the main clause of E's assertion.

The first possibility, S1, would be a structure-independent operation. A second source of the errors might be S2; it is unclear, as noted, whether this operation should be considered structure-independent or structure-dependent. A third possible source is S3; in processing terms, this explains the 'movement' of subject/AUX inversion as involving the insertion of an AUX at the beginning, and its later deletion. S3 says that, for difficult sentences, children forget to apply the latter rule. Since S2 and S3 both preserve the structural integrity of the relative clause, they pose little threat to the hypothesis that children invariantly employ structure-dependent operations. The following experiment was designed to disentangle these different possible sources of initial *is* in the prefix errors observed in Experiment 1.

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[11] Fifteen of the 26 responses to 9 were ungrammatical. Ten Type I errors were produced, all with *is* in sentence-initial position. These data suggest that children were conforming with the findings of Experiment 2, applying either processing operation S2 or S3 (cf. §5, below).

5.1. SUBJECTS. Ten of the children who made prefix errors in Experiment 1 participated in a second experimental session, approximately two weeks later, on sentences with different AUX's in the main and subordinate clauses.

5.2. DESIGN AND PROCEDURE. The procedures were nearly the same as in Experiment 1. The only difference was that more emphasis had to be given to the descriptions of the pictures. It was necessary to establish facts verbally—e.g., it had to be mentioned that one of the boys was able to watch TV, but one was not; or that one of the boys should have been working, but was sleeping.

5.3. MATERIALS. Two pretest sentences were used, serving two purposes. First, they reminded the children of the characteristics of the task; second, they introduced *can* instead of *is*:

(20) Pretest sentences
    a. The boy can jump.
    b. The red pig can stand on the house.

All the test sentences contain subject relative clauses. Test sentences 21a–b below are labeled 'IM' to indicate that *is* appears first in the relative clause, followed by a modal in the main clause. Assertions 21c–d have been designated 'MI' because the modal and *is* appear in that order:

(21) Test sentences
    a. The boy who is happy can see Mickey Mouse.   (IM)
    b. The boy who is unhappy should fix his TV set.   (IM)
    c. The boy who can see Mickey Mouse is happy.   (MI)
    d. The boy who should be working is asleep.   (MI)

Sentences 21a–b were designed to distinguish S3, in which the main-clause AUX is copied, from the other two sources of the error. To see this, consider these possible responses to 21a:

(22) a. *Is the boy who is happy can see Mickey Mouse?
    b. *Can the boy who is happy can see Mickey Mouse?

The initial *is* in 22a could result either by copying the leftmost AUX (S1), or by putting *is* before the test declarative, but not by copying the AUX in the main clause. The alternative error 22b precludes both operations S1 and S2, leaving only S3 as its source.

Sentences 21c–d disentangle operations S1 and S2, as shown by the possible responses:

(23) a. *Is the boy who can see Mickey Mouse is happy?
    b. *Can the boy who can see Mickey Mouse is happy?

Question 23a could result from either S2 or S3, whereas 23b implicates S1, the structure-independent operation of central concern.

5.4. RESULTS AND DISCUSSION. Three children made errors in response to the pretest sentences; but each of them made at least one correct response, so no child was excluded from further participation. All three ungrammatical responses contained sentence-initial *is* (*Is the boy can jump?*) These errors can be attributed unequivocally to operation S2.

For 7 of the 10 children, the target sentences in this experiment evoked more errors than Experiment 1: the 10 subjects combined produced ungrammatical utterances 65% of the time in Experiment 1, and 79% of the time in Experiment 2. Two possible explanations should be considered. First, VERBALLY encoding the relevant aspects of the situations, which were presented GRAPHICALLY in Experiment 1, may have exceeded some children's processing capabilities. Several children were less willing participants in this experiment, often refusing even to attempt certain questions. Perhaps they simply forgot the relevant facts about the situation, and so were unable to formulate the question. An alter-

native explanation is that some children may not have been able to use modals in yes/no questions as readily as *is*.[12]

What can we conclude from Experiment 2 about the origin of the prefix errors? Table 5 provides a breakdown of grammatical and ungrammatical responses to the two types of target sentences. This table underscores the point that either S1 or S2 can account for 6 of the 9 Type I responses to the IM sentences. However, for the MI sentences, no errors implicate operation S1. Among the errors designated as 'other' were utterances in which no AUX was moved—e.g., *The boy should be sleeping is snoring?*, as well as utterances which showed obvious confusion, such as *Should be ... the girl has to be ... where is the girl?* But no child uttered a sentence like 23b, *Can the boy who can see Mickey Mouse is happy?*

SENTENCE TYPE	CORRECT	INCORRECT	S1	S2	S3	II	III	Other
					ERROR TYPE			
IM	2	15	—6—		3	3	0	3
MI	5	12	0	—2—		4	0	6
Total	7	27				7	0	9

TABLE 5. Frequency of correct and incorrect responses by sentence type.

These negative findings invite the inference that prefix errors in both experiments were NOT due to the structure-independent operation (S1) of copying the leftmost AUX. More likely, the errors derive from strategies S2 and S3, which do not affect AUX inside a relative clause. We conclude, then, that the sentence processing routines of young children, as well as their grammatical hypotheses, do not violate principles of UG.

We have focused up to this point on the empirical question: Do children use structure-dependent hypotheses when they are confronted with complex sentences for which structure-dependent and structure-independent hypotheses produce different results? We pointed out at the beginning of the paper that the two kinds of hypotheses have the same consequences for many simple sentences. Indeed, as Chomsky 1971 notes, what is so striking about the structure-dependent hypotheses is that, although they appear to be computationally more complex than is necessary to capture the facts of question formation for SIMPLE sentences, children nevertheless invoke them when a simpler principle would do. This lends support to one of the central claims of UG, that the initial state of the language faculty has structure-dependence as an inherent property. This innateness in turn offers an answer to the fundamental problem of language acquisition, the 'poverty of the stimulus'—i.e., the fact that the hypotheses that children formulate are underdetermined by the input. The inference that structure-dependence is innate seems justified, though not guaranteed. In the

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[12] A more fine-grained look at the data reveals that the modals *can* and *should* educed slightly different results. Assertions 21a and 21c, which contained *can*, were processed correctly 5 times in 15 attempts. Only 2 of the 19 responses to 21b and 21d, which contained *should*, were grammatical. These findings suggest that some of the children were not able to apply their yes/no question rule to every AUX. Further support for this idea is obtained in Experiment 3, presented below.

next section, an alternative, learning-theoretic account of language acquisition is contrasted with nativism, and a third experiment is presented which puts the issue to an empirical test.

6. STRUCTURE-DEPENDENCE AND THE DEVELOPMENTAL AUTONOMY OF SYNTAX. In a recent critique of the innateness hypothesis, Stemmer 1981 proposes a semantically based account of the data which structure-dependence is commonly called upon to explain—in particular, the facts about yes/no question formation. Stemmer argues that his alternative account has the same empirical consequences as structure-dependence, but is preferable because it doesn't invoke innate grammatical knowledge; it can be acquired by the general learning capacity, semantic generalization. Stemmer's hypothesis (652) is given in 24 below, and he gives the following scenario for its acquisition:

Children first notice that, when the meanings of certain sequences of words are combined, the resulting 'compound' refers to a particular object. Then they experience a number of simple questions in which words like *is* and *will* precede such denoting strings. Eventually, these experiences lead them to grasp the following semantic generalization:

(24) Questions are formed by locating the *is* (OR OTHERS LIKE IT: *may, will* etc.), which follows the first compound that refers to a particular object, before this compound

This hypothesis is learned from simple data; but it produces the right question forms for complex sentences, like the subject relatives that served as test sentences in Experiments 1–2. In the following example, the first *is* follows the sequence *the man who*, which is not referential:

(25) The man who is tall is in the room.

The second *is* does follow a referential word string, *the man who is tall*; so this *is* can be preposed. This principle is maintained until a sufficient number of counter-examples have been encountered. Such counter-examples contain word strings (following *is* etc.) without the prototypical semantic attribute, viz. reference to a particular object (examples from Stemmer):

(26) a. Is running dangerous?
     b. Is his thinking correct?

After enough experience with recalcitrant positive data like 26, the child abandons the semantically based hypothesis 24, and derives a hypothesis based on syntactic constituency, e.g. Hypothesis II above. End of scenario.

It is not unreasonable to suppose that semantics and syntax are interleaved to some degree at early stages of language development. It is frequently claimed that aspects of semantic categorization predate syntactic categorization (for discussion and empirical data, see Bowerman 1973, Braine 1976, Gleitman 1981, Schlesinger 1971.) Furthermore, the potential virtue of a semantic generalization hypothesis like Stemmer's is that it fosters syntactic undergeneration. From a learnability perspective, undergeneration is preferable to overgeneration in language acquisition, since there are positive data for extending an undergenerating grammar towards the target grammar. In the

present case, the positive data consist of sentences like 26a–b (see also 27 below.) Negative data (i.e. ungrammatical sentences labeled as such), or some substitute, would be required to retract from an overgenerating grammar; but as noted earlier, negative data are presumably unavailable.[13]

However, since the final state of syntactic development is largely autonomous from semantics, any account which conflates syntax and semantics in language development must explain their subsequent disengagement. The simplest and strongest version of the innateness hypothesis, in contrast, maintains that children abide by universal syntactic principles from the earliest stages of language development. This issue of the developmental autonomy of syntax is addressed in the following experiment, which subjects Stemmer's hypothesis to an empirical test.

7. EXPERIMENT 3 was intended to evaluate Stemmer's semantically based account of the acquisition of yes/no questions. On this account, the first stage in the development of yes/no questions is semantically constrained. In particular, children are able to form interrogatives from assertions only if the words preceding *is* etc. refer to a particular object. But if the initial words in an assertion refer to an action or to an abstract object (as in 26 above), then corresponding questions cannot be formed. In syntactic terms, it is the subject NP that must have the canonical semantic feature of reference to a particular object.

By this criterion, another kind of subject NP should be exempt from transformation. As the examples in 27 indicate, expletives like *it* and *there* are semantically empty, i.e. non-referential. It seems clear that questions corresponding to these assertions are not sanctioned by Stemmer's hypothesis:

(27) a. There is a fly in my soup.
     b. It is easy to get lost in Boston.

As in Experiments 1–2, children were asked to form yes/no questions in response to experimenter's assertions. Here the assertions varied in their se-

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[13] Note that, since the final state of syntactic development is largely autonomous, semantic-based hypotheses must call upon some late-developing subsidiary mechanism to explain the disengagement of syntax and semantics—presumably on the basis of positive data. Moreover, discontinuous theory must explain why children don't have recourse to this mechanism at earlier stages. Despite the appeal of discontinuous theories, few viable candidates for such a mechanism have been proposed. One possibility is that triggering experiences are required—perhaps inputs that are too complex for young children to process. It is possible, however unlikely, that primary caretakers present children with finely tuned and sequenced inputs. Another alternative is that universal syntactic principles are biologically encoded, yet inaccessible to the grammar induction routines until a certain maturational stage.

In any case, the discontinuity approach—without explicating exactly what triggering experiences are needed, or when latent knowledge will be activated—is compatible with a much wider range of data than the simplest and strongest version of the innateness hypothesis, viz. that children abide by universal syntactic principles from the earliest stages of language development. By contrast, a continuous theory may endorse the innateness hypothesis in its strongest form. This conception of acquisition, then, can maintain not only the formal autonomy of syntax, but also its developmental autonomy. On this view, innate syntactic knowledge and simple input are sufficient for the acquisition of syntax, which should be rapid and error-free (cf. Hamburger & Crain 1984).

mantic properties. Systematic manipulation of the semantic content of the target questions permits a direct test for discontinuous acquisition. Again, the specific proposal is that the incipient stage, which is characterized by the semantic generalization, is later overturned in favor of a structural generalization. By contrast, the developmental autonomy of syntax predicts that, when children first begin to ask yes/no questions, the semantic features of subject NP's are irrelevant. On this view, all NP's are treated alike from the earliest stages of acquisition.

7.1. SUBJECTS. Fourteen children participated. They ranged in age from 2;9 to 4;8, with an average age of 3;9. The children in this study were younger than in the previous studies, permitting the investigation of earlier stages of question formation.

7.2. PROCEDURES were the same as in Experiment 2.

7.3. MATERIALS. The pretest sentences contained two examples each with *can* and *should*, and one with *is*. These sentences introduced the children to the task, and also were included in order to explore again the possibility of the stepwise acquisition of AUX's:

(28) Pretest sentences
    a. He can see the smurfs.
    b. He can run.
    c. This boy should have an umbrella.
    d. The mouse should be smoking.
    e. The dog is shooting the cat.

The experimental sentences were of two types. The subject NP's of the first two test sentences, 29a–b, referred to an action and an abstraction, respectively. The remaining test sentences contained expletives as subject NP's. Each of these had a corresponding semantic control sentence which closely resembled the test sentence in relevant semantic properties; however, the controls had referential NP's in subject position, instead of expletives:

(29) Test sentences
    a. Running is fun.
    b. Love is good or bad.

	CONTROLS
c. It is raining in this picture.	Rain is falling in this picture.
d. It is easy to see the little ghost.	The big ghost is easy to see.
e. There is a snake in this picture.	A frog is in this picture.

7.4. RESULTS AND DISCUSSION. Children made more errors in response to the pretest sentences than to the test sentences in 29. This is somewhat surprising, since the syntactic complexity of the test sentences would seem to be greater. However, four of the five pretest sentences contained modals—which, as we have already seen, can be troublesome for young children. We will return to results of the pretest presently.

The paucity of Type I errors is also striking, since this was the predominant error in the previous experiments. Even though this experiment was run on younger children, they had a higher over-all rate of success. The relative absence of errors suggests that the relative clause constructions in the earlier experiments were more difficult to process than the constructions in this experiment. This underscores our conclusion that most errors in the previous experiments were failures of processing, not of grammar; these errors resulted specifically from the processing complexity introduced by subject relatives. The basic results are given in Table 6.

	TOTAL	CORRECT	INCORRECT	TYPE I	OTHER ERRORS
Pretest	59	46 (78%)	13	3	10
Test	108	98 (91%)	10	0	10

TABLE 6. Frequency of correct and incorrect responses.

Table 7 provides a breakdown of the results for each of the different auxiliaries in the pretest, and for the different types of NP's in 29. The results of the test sentences clearly go against Stemmer's semantic account of the facts about structure-dependence.

	TOTAL	CORRECT	INCORRECT
PRETEST SENTENCES			
is	14	11	3
can	19	18	1
should	26	17	9
TEST SENTENCES			
Abstract/Action NP's	26	24	2
Expletive NP's	41	36	5
Controls	41	38	3

TABLE 7. Frequency of correct and incorrect responses by sentence type.

Returning to the results of the pretest, the first observation is that only sentences with *is* evoked Type I errors. However, sentences with *should* evoked more errors than those with either *is* or *can*: four children failed to produce an utterance with *should* on either opportunity. This is further evidence of the kind of piecemeal learning of AUX's noted previously in children's spontaneous productions (Kuczaj & Maratsos 1983). The implications of stepwise acquisition for linguistic theory are discussed below.

Note that these child subjects did not omit *should* from their utterances for SEMANTIC reasons. As the observed utterances below show, five of the children who failed to use *should* were cognizant of its meaning, but chose to recast it in other terms:

    (30) a. Is that boy should have an umbrella?
         b. Is that boy supposed to have an umbrella?
         c. Does that boy have to have an umbrella?
         d. Does that boy need an umbrella?
         e. Is that boy need an umbrella?

We can only speculate on the reasons for this restructuring. Perhaps the word *should* is not recognized as an AUX in these children's grammars because it shares semantic properties with main verbs like *have* (in *have to have*) and *need*. If so, these properties may inhibit the correct syntactic generalization that *should* is an AUX. Alternatively, *should* might be assigned to this category AFTER *is* and *can*, perhaps because it appears with less frequency in yes/no questions, on the supposition that frequency is a determinant in children's grammar induction procedures. In any event, it is encouraging, from a methodological point of view, to note that children did not opt for a yes/no question transformation for this word by analogy; i.e., this task does not seem to evoke errors which are not also observed in children's spontaneous speech.

To summarize, children in this study were impervious to the semantic fea-
tures of the NP's which served as context terms in their yes/no question trans-
formations. Expletives, abstract/action NP's, and referential NP's have all
been syntactically integrated into the grammars of these young children, which
appear to function autonomously. Stemmer's hypothesis is thereby discon-
firmed, at least for children in this age range. As predicted by developmental
autonomy, even the youngest child uniformly deployed a structure-dependent
rule in all the critical cases, rather than one based on a semantic association
with syntax. There was no evidence of discontinuous development, as sug-
gested by semantic bootstrapping. We did, however, observe evidence of the
stepwise acquisition of auxiliary verbs in yes/no questions. This turns out to
be disconcerting for one current proposal about the acquisition of syntax, as
we now show.

Our final topic is the empirical import of these findings for a parameter-setting
model of language acquisition. In particular, we focus on the Null Subject
parameter, which has received considerable attention lately both in linguistic
theory and in acquisition research. Parameter-setting models of acquisition
have been offered as partial explanations of the fact that clusters of syntactic
properties vary systematically across languages. One property that varies is
the presence/absence of a null element in the subject position of tensed clauses.
English does not allow superficially empty subjects (which aren't bound by an
operator), but Italian and Spanish do. Other properties covary with this one,
including the presence or absence of expletive pronouns and subject/AUX
inversion.

A parameter-setting model of acquisition relates a theory of markedness to
facts about the acquisition of properties that covary across languages. Each
parameter is a putatively universal syntactic principle with some unmarked
value which can be abandoned by the child in response to simple positive
evidence, in favor of some specific new value from a finite set. In the limiting
case, choosing a more marked value for a parameter is like setting a switch
which, in turn, sets other switches. Parameter-setting may therefore have im-
mediate repercussions throughout the child's grammatical system.

There are a number of proposals concerning the Null Subject parameter. The
one of concern here, proposed by Hyams 1986, is noteworthy in both its em-
pirical and theoretical content (see also Rizzi 1982). Hyams takes null subjects
to be the unmarked value; and she predicts restructuring for languages like
English, to ensure the presence of overt subjects in tensed clauses. According
to Hyams, restructuring occurs when children encounter sentences with overt
expletives, as in Experiment 3. She asserts that productive use of expletives
will be closely followed by the emergence of modals, which may then undergo
subject/AUX inversion. Hyams anticipates then that expletives, modals, and
interrogatives with modals should all emerge at about the same time in the
acquisition of Overt Subject languages.[14] The results of Experiment 3 do not

[14] In support of her position, Hyams discusses evidence from a number of longitudinal studies
of the spontaneous productions of young children. It is worthwhile to contrast our experimental
paradigm with the procedures of longitudinal studies. The latter are uniquely suited to investigate

fit this pattern, since every child produced sentences containing expletives, but several children seem unable to use at least one modal (*should*) in interrogatives. This kind of stepwise acquisition is discussed in Hamburger & Crain 1982; in the case of AUX's, it is supported by data from children's spontaneous productions reported by Kuczaj & Maratsos 1983.

8. CONCLUSION. Two main theoretical conclusions can be drawn from these studies on the acquisition of subject/AUX inversion. Experiment 3 clearly demonstrates that children's hypotheses about this 'transformational phenomenon' are not semantic in nature. Rather, it supports the view that syntax is autonomous from semantics, even at early stages of language development. Moreover, Experiments 1–2 show that children's syntactic hypotheses are tightly constrained. These experiments provide evidence that hypotheses based on serial order are not entertained in children's formation of the rule for subject/ AUX inversion, as dictated by Universal Grammar. A more compelling case can be made for Chomsky's claim that only structure-dependent rules are formulated in language acquisition. Finally, on the methodological side, we have shown that the paradigm of elicited production is a versatile and reliable tool for bridging theoretical and empirical research on the acquisition of syntax.

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children's successive grammars, as in Brown 1973, or the transitional states of a single grammatical rule, as in Hamburger 1980. They have also proven especially meaningful in establishing correlations in morphological development across subjects and across languages. By contrast, elicited production studies offer unmatched experimental control (cf. Hamburger & Crain 1982) which in turn permits cross-sectional investigations of children's grammars, with many subjects and at many stages of development. In the present case, it is precisely children's breadth of grammatical knowledge which is at issue, so elicited production data are appropriate.

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