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Thomas Roeper

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Linguistic Universals and
the Acquisition of Gerunds

Thomas Roeper

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1.0 Acquisition theories divide between those which assume an "instantaneous" model and those which assume an "interactional" or "maturational" model. It is not necessary to see these theories as incompatible. For instance, some of a child's assumptions about language could be subject to change (maturation) while others are invariant (as if acquisition were instantaneous). In the first half of this essay we shall develop a particular model of interaction that follows these remarks by Chomsky:¹

It is a coherent and perhaps correct proposal that the language faculty constructs a grammar only in conjunction with other faculties of mind. If so, the language faculty itself provides only an abstract framework, an idealization that does not suffice to determine a grammar.
Note that this conclusion, if correct, does not imply that the language faculty does not exist as an autonomous component of mental structure.

We propose that there exists an hypothesis-generator which is an autonomous linguistic faculty equipped with special-purpose heuristics. The sentences which serve as input to the hypothesis-generator must meet "the dual condition of compatibility with the structural principles of universal grammar and with relevant experience."² What defines "experience" is determined by other mental faculties.

In the second half of the essay we present experimental evidence that supports our theory. In brief we claim that children have universal knowledge of a distinction between the abstract categories nounphrase and verbphrase. That is, they understand the difference in meaning between (a) I enjoyed singing and (b) I enjoyed the singing where in the verbphrase gerund (a) I must sing, but in the nounphrase gerund (b) anyone can be singing. The argument both follows from the instantaneous model and defines a role for other cognitive faculties. We believe that it is through joint work on theory and evidence that progress arises. The details of our theory correspond quite well to the details of our experimental results in our opinion.³

1.1 Four Theories of Interaction

There are four kinds of interaction that have been proposed (explicitly or implicitly) in the literature. In their strong form these theories are incompatible; in a weaker form they may each play a role in an acquisition mechanism.⁴ The strong versions are: 1) the pragmatic theory: context controls the acquisition and comprehension of sentences; 2) the Cognitive theory: the linguistic universals are reflections of cognitive universals; 3) the semantic theory: the formal character of semantic rules is reflected in syntactic form; and 4) the perceptual theory: grammars are reflections of surface strategies derived from perceptual principles. We shall begin with a discussion of each theory (plus subtheories) and its relationship to hypothesis-formation. We conclude with an elaboration of the instantaneous model.

2.0 The Pragmatic Theory: Inference Procedures

Both child and adult must possess a system in which to provide a

mental representation of physical context. We shall label that system a set of inference procedures (although basic insights into this procedure are still missing). We provide an incomplete and intuitive definition of inference procedures that suits our limited purposes: inference procedures include the capacity to recognize intrinsic connections between objects. For instance, Clark⁵ has shown that in a situation where there is a bottle and a bottle-top a child easily infers where the bottle-top goes though verbal instructions may tell him to put the top underneath the bottle. We suggest that the same kind of inferences may operate between situations and words and between words themselves.⁶ Thus if a child hears the words "snow" and "shovel" s/he may assume that snow is what is shovelled. This inference process can work even where the two words are discontinuous: "shovel hay and forget snow" might be understood as "shovel snow" by a child using just inferences. Furthermore these inferential connections may in fact become part of the definition of lexical items.⁷

If children can apply situational inference procedures to the analysis of sentences, then it means that they have powerful non-grammatical comprehension strategies. We may now ask what the relationship is between inference procedures and grammars. There are many possibilities. We shall express them in terms of contexts (C) and sentences (S):

- (1) I. The child has a stable analysis of Context (C).
S/He selects lexical items from sentences (S) which match it.
- II. Child has a partial analysis of both C and S.
S/He uses either to supplement the other.
- III. Child has a stable analysis of S. S/he selects elements from C that match, enhance, or disambiguate S.
 - a. match = connects lexical items to things.
 - b. enhance = interpret pronouns and unspecified material.
 - c. disambiguate = choose among alternative structures for S.

We shall argue that III is equivalent to adult grammar while I and II represent discernibly different phases of the acquisition process.

In our model the child moves from I to III through a trade-off mechanism between inference procedures and grammar. A child relies on inference procedures to determine the meaning of a sentence until the point where the grammar can independently provide an analysis. The exact fashion in which this trade-off mechanism operates may be fairly subtle. We shall suggest one possibility that receives support in our experiment.

The acquisition literature contains evidence that points toward the presence of inference procedures (See Bloom (1973a), Roeper (1973a)). For example, Slobin⁸ found that children failed to understand reversible passives like (2) (or were slower), but comprehended non-reversible passives like (3):

- (2) the dog was chased by the cat
- (3) the sandwich was eaten by the policeman

We take failure on (2) (i.e. the dog chases the cat) to be a clear indication that the child does not control the passive. We can explain success

on (3) if we assume that the child is in stage II and an inference procedure to the words sandwich and policeman. Policemen eat sandwiches but not vice-versa.

The claim that children use inference procedures to comprehend (3) does not mean that they must use them to understand (4):

(4) the sandwich ate the policeman

If simple SVO structures are included in the grammar, then the trade-off mechanism would exclude inference procedures for (4). Therefore a child could perceive that (4) was nonsense using syntax. Thus the inference procedure would be restricted to "unknown" structures like (3) which contained uninterpretable syntactic and morphological material (is, -ed, by).

Inferences may also play a specific role in hypothesis-formation and grammar revision. The acquisition of the passive may be contingent upon two conditions: a confident inference of meaning and a syntactic analysis of object pre-posing and subject-postposing. Sentence (2), being reversible, would never allow a confident inference of who chases who. However a confident inference for (2) (that the policeman eats the sandwich) would trigger a syntactic analysis which was consistent with that inference.⁹ This view of acquisition requires that a sentence with a new structure meet a "dual condition of compatibility with the structural principles of UG and with relevant experience."

Note that there is no implied connection between the formal structure of the inference (whatever that may be) and the structure of the sentence. The natural connection between an animate policeman and an edible sandwich says nothing about the interpretation of by-agentives and the fronting of objects. In addition this proposal is not meant to exclude the possibility that parts of grammar are acquired purely through recognition of distributional differences and the application of transformations. It is not clear, for instance, what inferences could assist a child in learning affix-hopping.

In sum the trade-off mechanism defines a role for inferences about context in the acquisition of an autonomous grammar.

2.1 The Cognitive Theory

There are two claims about the relationship of general cognition to linguistic operations. They are not necessarily linked:

- (5) I. Maturational: linguistic operations are contingent upon prior cognitive operations.
- II. Universal: all linguistic operations are reflections of cognitive operations.

H. Sinclair (personal communication) has suggested that the "egocentricity" of a child may lead her to construe all missing subjects as referring to herself, until s/he maturationally outgrows egocentricity. Thus a 5-year-old may understand the doll is easy to see correctly for a non-linguistic reason; s/he assumes that s/he is the subject of verbs and therefore does not seek a linguistic interpretation of the missing subject of see. At a later stage children appear to go backwards¹⁰ because they misconstrue doll as the subject of see. Finally they realize the non-egocentric meaning

together with a deep structure analysis: it is easy for one to see the doll.¹¹ Thus we find that cognitive assumptions may temporarily interfere with language acquisition.

This maturational model makes no necessary claims about the power of the hypothesis-generator. The power to project certain rules of control and anaphora may be present in the child although the requirement of cognitive non-egocentricity prevents its application. It is of course difficult to prove the presence of mental powers if extraneous factors block their application, but perhaps not impossible.

One difference between linguistic mental powers and cognitive mental powers lies in their relationship to consciousness. The cognitive claims¹² deal primarily with conscious or near-conscious aspects of language acquisition. The output of some rules must be conscious because the meaning of a sentence must be conscious in order to be useful in communication. However the same formal properties that involve syntactic transformations are often present in unconscious aspects of the grammar. Transformations exist, for instance, in phonology although the rules of phonology are not conscious. We would make the general prediction, therefore, that a child will exhibit formal powers in spheres of mental functioning that do not entail consciousness, before they exhibit the same powers in spheres that do entail consciousness.¹³ Egocentricity would pose a barrier only to conscious rules presumably. In sum we find that both linguistic powers and cognitive powers are used in conjunction for the acquisition of some (but perhaps not all) rules.

Theory II represents the view of the philosophical tradition which preceded Chomsky and the view of many current philosophers and psychologists.¹⁴ The issue has often been misconceived by considering linguistic operations in isolation and not as an integral mechanism. Suppose we assume that every feature of linguistic ability has a correlate in general cognition. We discover however that they combine in just a small subset of possible combinations. The role of the grammar then is to stipulate a narrow set of possible links between cognitive powers as they involve language. Consider this hypothetical example. Suppose one can establish that hierarchies (trees) and recursion both exist within and beyond language. In addition suppose that noun and verb correlate with cognitive notions of "thing" and "action" (a claim we dispute). It is still necessary for universal linguistic restrictions to determine how these representations combine. For instance, the fact that some nodes (S, NP, QP) are recursive while others are not (DET, AUX, ADJ) is not predicted by any of the cognitive factors. Thus we can view the presence of recursion in general cognition as a trigger for the linguistic component which causes, automatically, certain labelled nodes in a tree hierarchy (but not others) to be eligible for recursive operations. We conclude that the significant role of general cognitive powers does not dissolve the need for an autonomous language faculty.

2.2 The Semantic Theory

There have been many proposals that suggest that the acquisition of syntax depends upon semantics.¹⁵ They are diverse:

- (6) I. Cognitive Semantics: the logic of situations and basic cognitive concepts combine to produce syntax.
 II. Formal Isomorphism: formal properties of semantic representations are identical to properties of syntactic representations.
 III. Formal Constraints: syntax and semantics each have separate formal representations that constrain the other.

Theory I claims that semantic relations map directly onto syntactic relations. The central claim is that actor-action-object produces the string NVN and the grammatical relations subject-verb-object.

It is important to realize that this claim makes strong assumptions about the form of cognitive knowledge: it assumes a linear and discrete cognitive language (or "mentalese" to use Fodor's term¹⁶). There is no (known) reason why the cognitive language must have the same formal characteristics as language, nor is there a principled reason that shows that they must not share formal characteristics.

The first objection to theory I is that languages which have SOV structure fail to mirror the linear order of actor-action-object. The second objection is that the semantic relations by themselves underdetermine the grammatical relations they seek to explain. The question remains of how a child learns that some grammatical subjects bear no relation to actors. The assumption that every language must encode actor-action-object places boundary conditions, perhaps, on grammatical relations, but they are weak conditions which leave the central questions unanswered.

Theory II derives from a suggestion by P. Kiparsky (based on Fiengo (1974))¹⁷ that people possess a linear concept of time which predetermines the order of elements in the auxiliary. If true, then children would not have to evaluate different possible orders for the auxiliary as suggested by Chomsky (1965). This theory allows a semantic system to directly constrain syntactic form because both share the same linear representation. The theory does not apply where syntactic forms do not serve distinct semantic functions.

Theory III presupposes independent syntactic and semantic representations. It claims that principles of semantic compositionality will constrain the set of possible syntactic analyses because not all possible syntactic analyses (for given input data) will be semantically well-formed. Partee (1977) has a number of interesting suggestions along these lines, using Montague grammar which requires that semantic well-formedness exist for subparts of syntactic strings through semantic constraints which apply at each stage of a derivation.¹⁸

In each of these theories there is a role for semantics in the acquisition of syntax. None of them eliminate the need for an independently defined syntax.

2.3 The Perceptual Theory

Two kinds of strategies have been proposed; they are easily confused:

- (7) I. Probabilistic Strategies
 II. Parsing Strategies

Theory I claims that children (and possibly adults) adapt a word-order strategy because it is true most of the time. Two strategies are representative: NVN = SVO and First N = Subject. Both strategies are induced probabilistically and relate to terminal strings with no structure-dependence. In contrast grammars and hypothesis-generators function as deterministic systems that are structure-dependent. Rules operate on every appropriate input and produce exceptionless outputs. There are no probabilistic components. Consider now an alternative view of grammar. Suppose one could establish that a probabilistic hypothesis was projected and accepted at some stage in acquisition. Suppose a child believed that the most frequent sentence types were grammatical and the least frequent sentence types were ungrammatical. If this hypothesis served as the basis for a subsequent stage in acquisition (a new generalization was based on it), then it would violate the predictions made by universal grammar. In this probabilistic model the generalizations (even universal ones) are the results of a probability-analyzer, which becomes a crucial innate language faculty. Each theory, the probabilistic and the deterministic (instantaneous), makes different claims about the kinds of mental operations involved in language acquisition.

It is important to note that there could be ancillary functions for a probability-analyzer (if it exists). A performance strategy might refer to a probabilistic judgement: First N = Subject unless the grammar indicates otherwise. The First Noun rule is not a structure-dependent rule and therefore cannot be a part of the grammar ("firstness" is not defined in either a hierarchical or a functional structure). The important point is that if the strategy plays no role in the projection of new hypotheses then it is an inconsequential by-product of the acquisition process. If it does play a role in hypothesis-projection, then a different theory of language is entailed. We shall suggest that the SVO = NVN strategy plays an important role in comprehension as an adjustment rule but that it plays no role in the projection of a new hypothesis. Other "overgeneralizations" may also fail to be true hypotheses about grammar.

Theory II suggests that perceptual strategies may provide boundary conditions on certain parsing strategies that enable a person to project a tree from a terminal string. For instance Chomsky and Lasnik (1977) have proposed a theory of filters which would conform naturally to a theory of perceptual templates. In addition, Tavakolian (1977) provides experimental evidence in behalf of a constraint on children's grammars at an early stage that requires all subordinate clauses to be treated as coordinate clauses. In other words new sentences attach to the S-node and recursion on other nodes is prohibited. Her principle is also consistent with a perceptual preference for flatter structures. It appears therefore that perceptual strategies and principles are important in language construction and use. Nevertheless perceptual strategies by themselves consistently underdetermine the data they apply to. They do not eliminate the need for a grammar.

2.4 Interactive Theories

We have discussed four versions of the interactive model which, though sometimes collapsed in the literature, constitute separate claims about how language is acquired. Each kind of interaction may affect performance

and, in principle, may restrict the hypothesis-space available to the child. What follows is a summary of one way in which each theory may be involved in hypothesis-formation. 1) Context: joint inferences between situations and the intrinsic content of words may enable a child to arrive at a confident inference of the meaning of an unknown sentence type. 2) Cognitive Maturation: conscious aspects of language may require non-egocentricity. 3) Semantic: where there is a consistent link between semantic form and syntactic form, one could determine the other. 4) Perceptual strategies: perceptual factors may place boundary conditions on rules for parsing and tree construction. None of these proposals constitutes an argument against the existence of an autonomous grammar nor dictates the fashion in which a child projects hypotheses. There must still be a specifically syntactic acquisition device which associates structural descriptions with sentences for various grammars and uses an evaluation metric to choose among them.

3.0 The Instantaneous Model

The instantaneous model (Chomsky (1965)) assumes that the child accomplishes the following tasks at once: a) receives a sufficient range of unanalyzed potential sentences, b) projects candidate grammars, and c) selects an appropriate grammar through an evaluation metric. The idealization is "obviously false"²¹ because the child does not learn the grammar at once and because the child uses less than a sufficient range of sentences when it projects candidate grammars. The idealized model leads to both accurate and apparently inaccurate hypotheses about a realistic model of language acquisition.

The putatively accurate hypothesis is that children will obey linguistic universals at all stages of language acquisition. There exist no reports in the literature of children disobeying fundamental principles of grammar construction such as the A-over-A principle, Left-branch condition, Complex NP Constraint.²² Also the experiment below suggests that major categories (NP and VP) are available at early stages. These constraints are so dramatic that, were a child to disregard them, it would be easily noticed. Current evidence therefore supports the view that linguistic universals extracted from adult languages can be regarded as constraints on a child's powers of hypothesis-formation.²³

Nevertheless there is another logical possibility. Universals could in principle be the output rather than the input in the process of language acquisition. If so, "conclusions regarding universal grammar would have to be modified".²⁴ Presumably the child would begin with a set of primitive universals, stated in slightly different notation, which are refined through the acquisition process. The argument goes like the growth of teeth. Adult teeth are not grown baby teeth; it takes a replacement process to get from the latter to the former. Thus far there is no clear evidence that children use a notationally primitive system at the early stages.

The instantaneous model appears to make inaccurate predictions about the final stage of acquisition. The "final stage" is when a full range of data is under consideration and a child projects an adult grammar. If at the final stage all previous hypotheses are reversible or discardable, then the existence of earlier grammars would be completely irrelevant to the form of the final grammar. Acquisition would then be effectively instantaneous. However evidence suggests that earlier grammars do influence later grammars. Therefore we propose that a realistic model departs from the

instantaneous model in the following ways:

- (8) a. Children initially project a grammar from a limited range of data.
- b. Some of their hypotheses are irreversible.
(i.e. once a rule is projected, it cannot be changed.)

These restrictions at once falsify the instantaneous model and simplify the acquisition process. Initial hypotheses are limited by a limited range of data. Subsequent hypotheses are, in part, limited by previous irreversible hypotheses. (For example, hypotheses about basic word-order may be irreversible.) In effect subsequent hypotheses must focus on a different limited range of data. (For example, transformational distortions of basic word-order.) This step by step limitation places substantial limits on the total range of hypotheses that a child must search through.

These restrictions also mean that the evaluation metric must function differently. The instantaneous model claims that one must evaluate every individual hypothesis in light of the whole grammar in order to determine if it is optimally simple. This can only occur in the final stage. If some hypotheses are irreversible when chosen then the evaluation metric must operate locally and choose among alternative hypotheses for each rule or set of rules as new data is analyzed. Thus the evaluation metric will never have to evaluate separate grammars at the final stage where every feature of language has a different analysis. This simplifies the evaluation process.

What evidence exists in behalf of the restrictions in (8)? It is clear that children have grammars long before they are able to comprehend or produce many types of complex sentence. Therefore they form grammars from limited data. (A subset of the sentences adults use.) It is clear that children must continue to revise phrase-structure rules long after they learn transformations because phrase-structure rules affect the verb complement system which is not mastered until late. Nevertheless not all features of phrase-structure seem to be open to re-analysis: no evidence suggests that children decide that all NP's are really VP's and vice-versa. Their revisions seem limited: for instance children first accept then reject "A your car" as they learn that possessives are part of the determiner system and not the adjective system. We conclude that (8b) is plausible but not easily subject to proof.

The two restrictions we have mentioned are not incompatible with the claim that the hypothesis-generator (HG) is fully-endowed from birth. By "fully endowed" we mean able to project any operation in any language with the appropriate data. We can maintain this claim, which follows from the instantaneous model, if we allow the HG to be data-driven.²⁶ That is the operations projected depend on the character of the data and not the power of the HG. Consider the following example. We know that children learn to identify verbs before they identify auxiliaries. Therefore it is not surprising that the power of transformational analysis comes into use in German at an earlier age²⁷ than in English since the verb-second (or verb-final) rule in German involves the main verb while in English the subject-auxiliary inversion rule involves the auxiliary. Thus the sequence of hypotheses that a child tests and the power they entail could be different

for each language. It is governed in part by the facts of the language and in part by the universal features of the HG itself (such as knowledge of the connections exhibited by language typologies).

It could nevertheless be correct to place limits on the power of the HG:

- (9) Not all hypotheses are available in the initial phase.

This restriction follows from a maturational view: the power of the HG itself changes over time. The restrictions of (8) and (9) together would further limit the total range of hypotheses that a child must consider. There are some proposals for such restrictions which receive support in experimental data developed by our research group: S-node attachment principle;²⁸ restriction to homogeneous rules;²⁹ disjunctive ordering principle; restriction against optional transformations.³⁰

It is very difficult to prove, however, that (9) is necessary. We do not know, for instance, whether recursion is at first excluded from the HG for maturational reasons or because of the fact that a child must understand simple sentences as a pre-condition for projecting complex ones. All of the other proposals could also be either constraints on the sequences in which hypotheses are projected or constraints on the power of the mechanism. In either case the exclusion of hypotheses simplifies acquisition. The question of maturation is of primary interest with respect to the role of language development in a child's overall cognitive development.

We shall now sketch a mechanism for acquisition that incorporates our discussion.

3.1 An Hypothesis-Generator

Our mechanism will have the following components:

- (10) a. A grammar
b. An Hypothesis-Generator
c. An Input Filter
d. Adjustment Rules
e. Inference Procedures

The HG contains two kinds of universals: trigger and search. They can be roughly defined as follows:

- (11) Trigger: if X, then Y
Search: if X, then Y, Z, or W.

A possible trigger universal might be: if a noun is discovered, it is the head of a nounphrase. The hypothesis is confirmed as soon as a nounphrase is analyzed. Trigger universals are natural candidates for irreversible hypotheses. That is, a child who identifies nouns and then nounphrases will not be able to decide at a later point that he had chosen the wrong class as nouns.

Search hypotheses are required where several possibilities exist. Suppose a child has learned SVO and the HG now wants to identify the indirect-object. It will then analyze sentences of the form SVNO, SNVO,

SVON, and SVOprepN to determine which N's can be analyzed as indirect-objects and which structure is a reflection of deep structure. One or the other of these structures may be mistakenly "confirmed" and appear in a non-adult grammar. For instance, our evidence below suggests that children do not realize that indirect-objects are limited to the prepositions to and for. Each decision by the HG will instantiate another set of hypotheses.

3.2 An Input Filter

The apparent input to the HG is the speech in the environment of the child. The environment presumably contains a full range of sentence types. However if the child chose any sentence to analyze, it might have to project and discard numerous vastly inaccurate hypotheses. We propose that the child possesses a mechanism that selects the input to HG: an input filter.³¹ The input filter follows a very simple principle: it includes what is analyzable and excludes what is unanalyzable.

The input filter operates on two levels. First it excludes sentences with "unknown" morphological and lexical³² material. Second it selects sentences that fit current projections of the HG. The HG must therefore provide surface-structure features of possible input sentences to the input filter. Sentences excluded in either way will move to the adjustment rules. The input filter provides a mechanism whereby we can predict that children pass through all stages in the same sequence, because it allows children to control the sequences of structures analyzed. It would, for instance, allow several structures as inputs to the HG in order to search for the indirect-object.

3.3 Adjustment Rules

We have mentioned one mechanism whereby a child can understand sentences that its grammar rejects: inference rules. We suggest that there is a second mechanism which takes sentences rejected by the input filter and sends them back to the grammar: adjustment rules. The adjustment rules will delete both unknown and unanalyzable materials in order to make the utterance fit an existing pattern. In particular, complex sentences will be adjusted to fit the structure SVO.³³ Deletion turns a passive the dog was chased by the cat into the dog chased the cat.

Adjustment rules are fundamentally different from grammatical rules. Grammatical rules allow variables between constituents but the contents of variables must be subject to examination to guarantee that they contain nothing which violates a syntactic constraint. (See Chomsky (1973) "Conditions on Transformations"). Therefore the content of variables cannot be unknowns. Furthermore if we were to allow "variable-unknowns" in the rules of a child's grammar, then we would develop rules that are so abstract that it would be difficult for an evaluation metric to reject them.³⁴ The structural description for a simple sentence would contain superfluous ("essential") variables: X-S-Y-V-W-O-Z. Our proposal to call such a rule an adjustment rule means that it would never have to be evaluated by an evaluation metric as a possible rule of grammar.

We propose in addition that adjustment rules meet a much stronger constraint than grammatical rules:

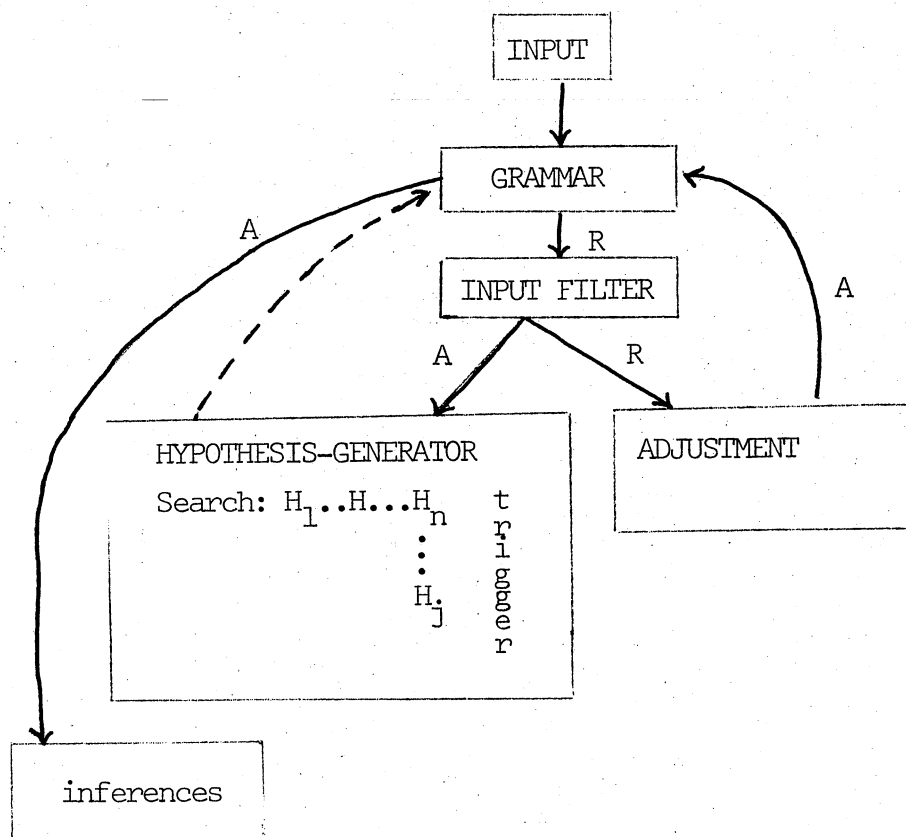
(12) Only function words may be deleted.

Thus movement transformations are excluded and lexically filled items are excluded.³⁵ Sentences which are converted to known structures are then returned to the grammar. Sentences which cannot be reduced to known structures or contain unknown lexical items move to the inference rules.

Inference rules are accessed for two purposes. They construe the meaning of sentences which do not fit into the grammar and they supplement the grammar by interpreting pronouns and other forms of unspecified material.

3.4 Summary

We present a flowchart of these components:



A = accept
 R = reject
 - - - = new hypotheses

An arbitrary sentence moves through the system as follows:

1) The sentence enters the grammar. If known, it is analyzed. If it is composed of unknown elements or it is unanalyzable, it enters the input filter.

2) The input filter examines the sentence to see if it matches the surface characteristics of current projections from the HG. If it does then it passes into the HG. If not, it is classified as a non-sentence and moves to the adjustment component.

3) The HG matches the sentence to a trigger or search hypothesis. If it is a search hypothesis, the sentence may be held until other sentences are found which help determine which of several hypotheses is correct.³⁶ Alternatively one of the search hypotheses may be chosen and sent to the grammar. A later sentence may cause the hypothesis to be reversed and the grammar changed.

4) The adjustment rules take rejected input sentences and convert them into sentences acceptable to the existing grammar. If a sentence is not reducible, it moves to the inference component.

We turn now to our experiment in which we find evidence for the different components in this sketch of an acquisition mechanism.

4.0 The Experimental Domain

It has seemed self-evident to many investigators that children are born with the notions of sentence and word. We shall argue that they possess a concept of equal importance that falls between word and sentence: phrase. Each of these concepts serves as a "primitive" in grammar construction insofar as it serves as a necessary domain for the projection of other rules. Therefore it should be natural that a child seeks to define the notion of phrase (as well as word and sentence) at an early stage in the acquisition of a particular language.

One feature that distinguishes nounphrases from verbphrases is control. In Wasow and Roeper (1972) we showed that verbphrases imply sentences which require subjects while nounphrases have optional or unspecified subjects:³⁷

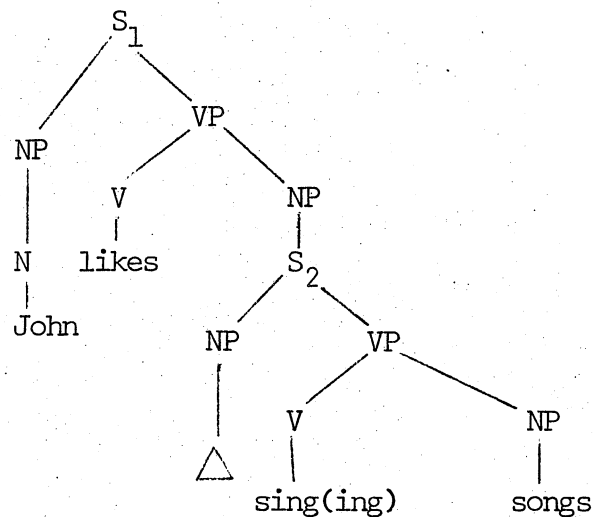
- (13) a. John likes singing songs (verbphrase gerund)
 b. John likes the singing of songs (nounphrase gerund)

In (13a) John is the subject of singing while in (13b) the subject is unspecified: anyone can do the singing. The same difference arises when we use negatives and adverbs to mark what we call nominal and verbal gerunds:

- | | | |
|------|------------|--------------------------------|
| (14) | Verbal | <u>John</u> |
| | Negative: | a. John enjoys not singing. |
| | Adverb: | b. John enjoys loudly singing. |
| | Nominal | <u>anyone</u> |
| | Negative: | c. John enjoys no singing. |
| | Adjective: | d. John enjoys loud singing. |

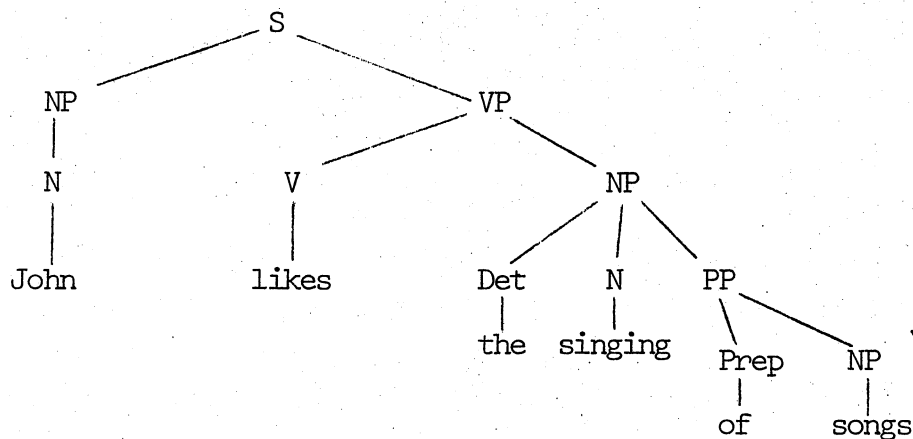
In (14c,d) singing must be considered an ordinary noun; -ing marks the nominal form on some verbal roots just as -tion does on others (destroy/destruction). The tree structures are distinct for nominal and verbal gerunds:

(15a)



The delta (\triangle) in (15a) requires that a rule interpret the subject of singing.

There is no delta in the nominal form (15b):



It is possible for an optional subject to appear within the determiner (as in the man's singing). If no optional subject appears, then the subject of the nominal gerund is not specified by grammatical rule and is open to contextual interpretation.³⁸ That is, we perceive in context or we imagine the equivalent to a subject for the singing, namely, a person who sings.

If this distinction between nounphrases and verbphrases is universal, then it may be innate. We cannot prove that the distinction is innate, but the assumption that it is innate has an important consequence. Under the innateness assumption, the child's task is not to infer the existence of the principle (a control difference) but simply to recognize where it applies. The child must learn to recognize that gerunds are nounphrases if they are marked by a determiner (the), negative (no), or adjective. If a gerund has a nominal marker, then it is automatically uncontrolled. Until, however, children learn to recognize these noun-markers, we would

not expect them to exhibit knowledge of the nominal/verbal difference.

There is a second feature of nounphrases which is predictable by universal grammar: if the nounphrase has an explicit subject, it will be stated within the NP. It can occur either in the determiner or in a prepositional phrase (the jumping of the horse). We can see that the PP falls within the NP in the diagram above.

In two experiments we have sought to determine when children recognize noun-markers and the control properties that they have. In addition we have designed the experiments so that a pragmatic strategy and a perceptual strategy produce results different from those predicted by universal grammar. In keeping with the interactive theory we expected that children might follow non-grammatical strategies, especially at the younger ages.

4.1 We shall review the hypotheses before we present the experimental design:

The various hypotheses make different predictions about these kinds of sentences:

- (16) a. Can you show John fighting
 b. Can you show John the fighting
 c. Can you show John the fighting alligators
 d. Can you show John the alligators fighting
 e. Can you show John the fighting of the alligators
 f. Can you show the alligators hit by John

The universal grammar (UG) hypotheses are:

- (17) I. Children will recognize control differences for nominal and verbal gerunds.
 II. Children will take post-verbal prepositional phrase as subject in nounphrases (optionally).

Hypothesis I predicts that children will interpret (a) and (b) differently, supplying a pragmatic subject for (b) from context. In (c) they will take alligators and not John as subject because of the presence of the which indicates that fighting is an adjective in this sentence. In (e) they will interpret alligators as subject or object of fighting but not John; John is ineligible because it falls outside the NP.

The perceptual hypotheses, which we shall call (surface structure) SS-strategies, predict that children's knowledge of language functions in terms of the sequence of lexically filled items. We have therefore two hypotheses and two subhypotheses:³⁹

- (18) I. Any NVN sequence will be interpreted SVO
 a. NV will equal SV
 b. VN will equal VO
 II. The First N is the subject

The SS-hypothesis predicts that both (a) and (b) will be interpreted SV.

Likewise (c) will be interpreted as if no the were present (CYS john fighting alligators). In addition (e) and (f) will be interpreted as SVO because the strategy is insensitive to prepositional phrases and passives. Sentence (d) will be interpreted with John as the subject according to the First N hypothesis. All of these hypotheses assume that noun-markers are irrelevant to interpretation because they are not lexically filled.

There are several pragmatic hypotheses. The first hypothesis is consistent with universal grammar:

- (19a) I. Children will supply missing subjects and objects pragmatically where the syntax requires it.

Thus the children will supply a missing subject in (b) because John cannot serve as subject. They might supply a missing object in (d) if they do not interpret the verb fight reciprocally. They might also supply a missing subject in (e) if alligators is interpreted as object. These uses of context are what one can call "syntax-driven".

The second pragmatic hypothesis assumes that children will respond in a way that is consistent with their visual context. The experiment includes a distinct visual bias in order to elicit this interpretation:

- (19b) II. Children select verbal information to supplement their understanding of the logic of the situation.

There is a third hypothesis which involves a combination:

- (19c) III. Children use inferences about context just where grammar fails.

Under III we would predict that the children would interpret (a) correctly, but would respond either randomly or in terms of context to the passive (f). They might also interpret (b), (c), and (e) incorrectly or in terms of context because they recognized that the noun-markers changed the syntactic string but were unable to interpret what they meant.

4.2 Methods

Subjects: a group of 44 children from two daycare centers were used in the experiment. They ranged in age from three to eleven with 19 in the 3-4 range, 17 in the 5-7 range, and 8 in the 8-11 range. Thus we had two larger groups for the younger ages where we expected to find non-adult grammars. The older group was intended to function as a virtually adult control. The children came from middle and lower-middle class backgrounds.

Materials: A Fisher-Price barnyard supplemented by a tractor, trees, four people and a few other animals were used. In addition a corral, which we called the "showplace" was attached to the barn, and a bench or a large piece of paper was put outside the corral. We called the bench the "watching place". The animals were varied in each sentence and an array of ten different animals was used in each of the first and second halves of the experiment in order to avoid monotony and keep the child's search time short.

Two experimenters were involved. One played and talked to the child while the other sat behind the child and recorded both actions and conversation pertinent to the interpretation of the sentences.

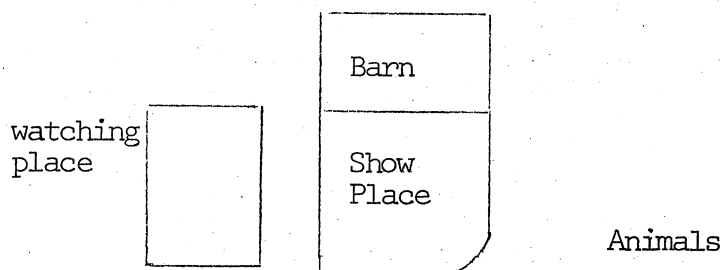
Design: the data were analyzed using a repeated measures analysis of variance across subjects grouped by age. Each subject contributes a proportion correct for each experimental condition. Thirty-seven sentences (see appendix), each of which began Can you show...., were developed for the following conditions:

- (20) a. Sentences with and without an explicit indirect-object
 b. Verbal gerunds (= declaratives)
 c. Nominal gerunds
 d. Passives
 e. Sentences with compound stress
 f. Sentences with post-gerund prepositional phrases

The sentences were arranged so that different animals and actions were involved in each one. They were also arranged in such a way that they proceeded from easier to harder. This was to guarantee that we would be able to obtain a sufficient sample from younger children to compare them with older children and we would be able to elicit further information from older children. Many of the sentences were somewhat unusual and unfamiliar in form. This increases the likelihood that correct responses are rule-governed.

Procedure: the children were introduced to each of the animals and allowed to play with them briefly.

Then we instructed them in understanding the "showplace" and "watching place" illustrated in the diagram:



The purpose of these two places was to introduce a deliberate pragmatic bias. The "watching place" served as a constant visual reminder that some nounphrase should be interpreted as "watcher" or, in effect, as indirect-object. The instructions added verbal suggestion to visual suggestion in the following way. We gave the children a pretest that included these sentences:

- (21) Can you show the chickens the horse
 (22) Can you show the horse

If the child failed to perform correctly on (21) the experimenter showed him or her how to put the chickens in the watching place and the horse in the showplace. Then in the performance of (22), if the child failed to

spontaneously insert a watcher, we would ask "who's watching". If the child still failed to insert a watcher we would show him that he could put any animal into the watching place. A further sentence in the pretest established that the children understood that a "watcher" was required for all sentences and that they should make a pragmatic insertion where the watcher was not mentioned. The instructions in the pretest referred to pragmatic insertions of indirect-objects; nothing indicated that the child could or should extend the notion of pragmatic-insertion to include subjects or objects.

4.3 Restatement of Hypotheses in terms of Experiment

Universal Grammar: The theory of UG predicts that children will be sensitive to control differences as soon as they are sensitive to noun-markers. Therefore it predicts that:

- (23) I. Children will comprehend the+gerund correctly
- a. By insertion of a pragmatic subject
 - b. By taking object of post-gerund PP as subject

In particular we predict that children will use pragmatic insertion for sentences like CYS Mary the jumping (Appendix: 13, 14, 15, and 33), or a prepositional phrase NP for CYS the jumping of the kids (3, 13, 15, 18, 22, 29, 31). Where no noun-marker exists, we predict SVO interpretations, e.g. CYS Mary hitting the dog (4, 8, 17, 28).

This hypothesis makes no predictions about when children will learn passive or compound stress. Both passive and compound stress are, of course, generable within UG, but they are not necessary UG features that are required for the projection of further rules. Therefore we informally predict that the efficient acquisition mechanism could afford to learn them after the recognition of articles as NP-markers.

SS-Hypotheses: these hypotheses are sufficiently general to apply to many types of sentences. The SVO hypothesis will operate on gerund declaratives (4,8,17,28), passives CYS the trees cut down (23,32,37), and contrastive stress CYS the sheep-kissing turtle (20,25,34,35). In addition it will operate on those sentences which have nominal gerunds preceded by an indirect-object in contradistinction to the UG hypothesis CYS the cow the hitting of the horse (13,15).

The VN = VO subhypothesis will apply to CYS the jumping of the kids (3,22,18,29,31). In other words it predicts the opposite of UG for these sentences. It also predicts that some passives will be correct CYS the cut down trees (9, 27) and others will be incorrectly understood CYS the trees cut down (19,23).

The First N = Subject hypothesis predicts that those forms with a post-gerund PP (3,22,18,29,31) will receive subject interpretations. It agrees with UG predictions in this instance and disagrees with the VN = VO predictions. The crucial elements for this hypothesis are those sentences that disagree with UG, namely, sentences like CYS the kids the bears hitting (2,21,26) where First N predicts that kids will be chosen as subject.

A different kind of prediction must also be made. If we find that

the SS-hypotheses are followed some of the time but not all of the time, then we must search for the conditions of their application. If we find that they apply just when syntactic rules are not yet present, then we must consider the hypothesis that they are adjustment rules that presuppose a grammar and not strategies that are a substitute for a grammar.

Pragmatic Hypotheses: the first pragmatic hypothesis is identical to the UG hypothesis insofar as missing subjects are concerned. Subjects are supplied pragmatically where they are not mentioned syntactically. Objects may also be inserted although they are not always obligatory.

Hypothesis II states that visual context determines how the child will respond. This predicts that all responses will involve an indirect-object because the visual context requires that the watching place be filled (and this is reinforced by verbal instructions). A subhypothesis is that pragmatically chosen indirect-objects will occur just where the grammar fails, that is, just where the grammar does not supply an indirect-object. This includes twenty of the sentences (3,4,8,10,12,17,18,19,20,22,23,25,28,29,31,32,35,37,38). Other sentences could be included if they are not given SVO analyses.

Hypothesis III predicts that inference procedures, based on context or word-meanings, may (a) determine which of two possible meanings a child takes, or (b) determine the meaning of sentences or phrases not yet generated by the grammar. The inclusion of "phrases" in (b) is important; it implies that a child might determine the meaning of part of a sentence through grammar and part through inference procedures. The sentences (3,7,10,11,12,13,15,16,18,22,27,29,30,37,38) which contain post-gerund prepositional phrases are particularly relevant to this hypothesis (Can you show the kicking of the elephant by Bill). In addition, as Slobin found, we expect that inference procedures may affect the comprehension of passives.

5.0 Results

Overall There were 1266 responses from a total of 1628 possible responses. Thus 78% of the sentences were responded to with an average of 79.6% per child. There were a total of 214 pragmatic insertions of all kinds from a total of 1496 (34 sentences) possible responses where pragmatic insertions are grammatical.

5.1 Universal Grammar

Hypothesis I: the contrast between sentences which contained a noun-marker (13,14,15,33) of the general form CYS Mary the jumping and sentences which contained no noun-marker CYS Mary hitting the dog (4,8,17,28) was clearly significant. Subjects inserted a pragmatic subject in the noun-marker sentence 28.2% (39/138) more than in the non-noun-marker sentences 1.2% (2/163), $F(1,41) = 33.8$, $p = .001$. There was no significant difference with age.

These results can be further analyzed if we divide the noun-marker class. While all of the noun-marker sentences could take an inserted pragmatic subject, it was primarily those like CYS Mary the jumping that actually received pragmatic insertions and not those sentences which had a

prepositional phrase: CYS the cow the hitting of the horse. 37/39 pragmatic subject insertions occurred in sentences with no prepositional phrases. Those sentences with prepositional phrases used the prepositional phrase objects as subjects (to which we shall return). Now if we define the UG response as either pragmatic subject insertion or use of prepositional object as subject, then the noun-marker sentences had 48.6% UG and 45.7% non-UG responses (in this case SVO). In the sentences without noun-markers we found 98.8% SVO responses and 1.2% pragmatic insertions. In other words, half of the responses to the sentences with noun-markers deviated from SVO structure in ways consistent with UG.

Hypothesis II states that children will not choose a subject outside the NP (but in the sentence). We found that 93% (28/30) of the responses for 13 and 15, of those consistent with UG, took the object of the preposition, which falls inside the NP, as the subject. Of the total set of responses 42.8% (24/56) chose the N outside the NP as subject. The evidence, therefore is mixed; we find however that the latter group (42.8%) can also be analyzed as using the SVO-SS hypothesis.

Stronger evidence for HII comes from the set of sentences where there was no outside noun explicit. The child therefore had a choice between taking a post-verbal subject or making a pragmatic insertion:

- (24) a. CYS the kicking of the horse
 b. CYS the jumping of the kids
 c. CYS the jumping of the fence

We found that 100% took horse as subject in (24a), 98% gave kids as subject in (24b), and 77% gave fence as subject in (24c), where the noun was inanimate and, by inference, a very natural object. 22% gave pragmatic subject-insertion for (24c). If we now compare those sentences where there was one noun mentioned, we find once again a significant difference between those where the noun precedes the+gerund, falling outside the NP, and those following the+gerund, falling inside the NP. Sentences of the form CYS Mary the jumping had the outside noun (like Mary) as subject 51% (39/76) while sentences like (24) had the object of the preposition as subject, an inside noun, 92.6% (114/123). There was no significant difference with age.

5.2 Compound Stress

One set of sentences was consistently interpreted incorrectly: compound stress. The children consistently gave SVO responses for sentences which, if the rules of English had been applied, would have produced OVS: 94.4% (70/74) gave SVO responses to (34,35).

5.3 SS-Hypotheses

Hypothesis I (NVN = SVO): the sentences that had no noun-marker were consistent with both SS and UG (4,8,17,28). They received 98.8% SVO. The sentences which had compound stress were consistent (94.5%) exclusively with the SS-hypothesis. The sentences with noun-markers were half and half (13,15): 51.5% UG (67/130) while 48.4% SS (63/130). It is clear that the SS-hypothesis had a significant role even in those sentences that had a noun-marker.

The subhypothesis VN = VO received virtually no support in light of the statistics for (24).

Hypothesis II (First N): this strategy makes the same predictions as HII for UG with respect to (24). It is supported inasmuch as 92.6% took the First Noun, namely the post-verbal one. It also makes the same predictions as HI for SS wherever the verb is preceded by just one noun. We must therefore find sentences where the prediction for the First N differ from UG and HI of SS. Those are sentences of the form CYS the kids the bears fighting (2,21,26). The evidence here is clearly inconsistent with the First N hypothesis: 88.3% (99/112) took the second noun as subject (consistent with adult English and UG), while only 10.7% (13/112) took the First N. The First N hypothesis, as distinct from the SVO-hypothesis, does not receive support.

5.4 Pragmatic Hypothesis

We contrasted five sentences (2,14,17,21,33) where subject or object insertion was either obligatory (CYS Mary the jumping) or natural (CYS the horse's kicking). These were contrasted with 25 sentences (See 4.3 above) where indirect-object insertion was natural. We found that, despite visual prodding and verbal instruction in the experimental design, there was a strong preference for either subject or object: 40.1% (79/198) as opposed to indirect-object: 2.8% (26/931), $F(1,41) = 143.7$, $p = .001$. There was no effect of age.

Another informal result deserves mention. The sentences that received object-insertion were disproportionately of one kind (25b):

- (25) a. CYS the kicking of the horse (4/41 or 9.7%)
 b. CYS the cow's kicking (13/41 or 31.7%)

This generalization holds across all contrasts where there is a post-gerund prepositional phrase and an empty object position. We have not computed the result more precisely because it is complicated by a lexical factor: fight, kick and hit were predominant in the verbs that took pragmatic object insertion.

In general 96% of all pragmatic insertions occurred precisely where they were required by the syntax. Of these 53% occurred with agentless passives and 43% occurred with nominal gerunds. The occasional unrequired insertions included, for example, adding an additional animal as subject to the one that was mentioned.

We turn now to evidence for inferential processes. There was a surprising inability to comprehend prepositional phrases correctly. The prepositions by, to, and of were often interchanged in meaning. In particular, 32% of the by-phrases were interpreted as indirect-objects. However 51% of the to phrases were not interpreted as indirect-objects (or locatives). In general 58.8% (174/297) of the prepositional phrases were correctly comprehended, and 41.2% were incorrectly comprehended (excluding passives). The breakdown in terms of age was significant: 3-4 yr-olds answered 35.9% correctly, 5-6 yr-olds answered 63% correctly and 7-11 yr-olds answered 73.7% correctly ($F(1,41) = 17.9$ $p = .001$).

The overall scores on passives was 80% correct with variation from 100% correct to 59% on individual sentences that differed radically in

plausibility. (See Austin (1976) for a discussion of why passive by-phrases may be understood more easily.)⁴⁰

6.0 Discussion

Noun-Markers There is clear evidence that a significant proportion, roughly half, of the children in the youngest group (3-4yrs) were sensitive to noun-markers in English. Their sensitivity entailed knowledge of UG because they selected either a pragmatic subject or the object of a preposition, within the NP, as subject. This provides evidence for our hypothesis that children would know universal features of noun-markers as soon as they recognized that articles marked nouns and nounphrases. The fact that children exhibit this ability at a young age is consistent with the argument that the recognition of nounphrases is a precondition for the projection of other syntactic rules. In other words, an acquisition device is more efficient if it focuses upon the location of noun-markers before it entertains other hypotheses that do not feed further syntactic rules.

The universal syntactic properties are not the only features which distinguish articles in English. They have special semantic properties in addition. If children focus upon articles, then we might expect them to learn both the syntactic and the semantic properties of articles. Independent research by M. Maratsos⁴¹ shows that very young children control surprisingly subtle aspects of the meaning of articles. Through the following experiment (and a number of others) he showed that children between three and four knew that the refers to a specific noun while a refers to a member of a set. Children were given the following introductory sentences plus either (a) or (b) for them to act out:

(26) There is a row of chairs and a boy. The boy sits down in one of the chairs.

- a) Just as he sat down, suddenly a chair fell over.
- b) Just as he sat down, suddenly the chair fell over.

Over 85% of the children correctly indicated that either (a) the chair occupied by the boy did not fall over, but one of the others did, or (b) the chair occupied by the boy fell over. This experiment shows awareness of a semantic distinction which is also, putatively, universal and might be very difficult to infer if it could not be triggered.


The fact that syntactic and semantic knowledge coincide in the acquisition of articles allows us to exclude another logical possibility. Suppose we were to argue what might be called the "interruption hypothesis": children have a strategy of NV = SV but if anything intervenes between N and V, then the strategy is upset and the selection of subject becomes either random or subject to extraneous factors. Our evidence combined with Maratsos' suggests that children are specifically aware of articles. Therefore they should be able to recognize that it is an article, and not random noise, which precedes the gerund. In a later section we shall provide further evidence against the "interruption hypothesis".

6.1 Compound Nouns

Our results also provide equally clear evidence that children do not understand compound stress (CYS the sheep-killing dogs). There is evidence that children hear and understand compounds but do not focus upon stress as a diagnostic.⁴² There are two possible reasons why a child's acquisition device would focus upon the acquisition of articles before learning compound stress. The first is that command of compound stress is linked to a system of learning lexical items which may proceed in an altogether different fashion from syntax learning. The second reason is that the recognition of compound stress is not a precondition for learning other syntactic rules and therefore may not be a trigger for other hypotheses.

6.2 Prepositional Phrases and Islands

We turn now to the claim that UG does not permit subjects of NP's to be derived or controlled from outside the NP. There are a number of ways in which this universal can be stated. A strong version of this claim is the suggestion by G. Horn⁴³ that NP's are islands. That is, they permit neither insertion nor extraction of elements, and in particular, subjects. With respect to our examples, the following transformation is ruled out:

(27) CYS the horse the ___ kicking


In other words a universal principle excludes a transformation which, otherwise, could be formulated in transformational terms and which, therefore, could appear as a hypothesis projected by LAD. Our evidence does not prove that the island-concept is correct. However if we assume that it is correct, then we find that there is a natural explanation for our results. First note that there is a subject-postposing transformation, within the NP, which produces post-gerund prepositional phrases:

(28) the horse's kicking \implies the kicking of the horse

Second we note that almost 100% of the children allow the object of a preposition to serve as subject in sentences like (28). This is what hypothesis II predicts because the PP falls within the NP. Third we have evidence which is compatible either with an extraction transformation, which violates the island-concept, or with the SS-hypothesis. The evidence is the fact that 45.7% of the children took Mary as subject in sentences of the kind CYS Mary the jumping. We note now the discrepancy between the two cases: in (28) we have virtually 100% taking the object of a preposition, while in the sentence above the results are inconsistent. If the extraction transformation and the subject-postposing transformation are equally formulable within transformational grammar (which is a fair assumption, though not necessary), then we would have no reason to expect a discrepancy. However if we assume that the extraction transformation is ruled out by a universal condition, then we can assume that the inconsistent results are the result of the application of an SS-strategy, while the consistent results on (28) are the result of a grammatical transformation. Now we have

explanation which accounts for the discrepancy in results but which entails the assumption of the island-constraint (or one akin to it).

This argument may seem complex but we believe it is an appropriate kind of argument for acquisition research. If our aim is to build an acquisition mechanism, then we cannot proceed by isolating each component and subjecting it to "independent" proof, since most components only function in concert with other components. Thus in order to argue that a given result is not due to a transformation we must refer both to constraints on transformations and the concept of adjustment rules. We turn now to adjustment rules.

6.3 SS-Hypotheses

In the test sentences which contained verbal gerunds both the UG hypothesis and the SVO-hypothesis make the correct predictions: NVN = SVO. It is the sentences with noun-markers that distinguish the hypotheses. We found that these sentences split between responses consistent with UG and with the SS-hypothesis. This result is consistent with the view that the SVO-hypothesis is an adjustment rule that operates wherever the grammar fails. In other words, some children perceived a conflict between the noun-marker the and the lexically filled verb jumping. Either the syntactic function of the (as a marker of verbal NPs) was unknown or the function of the lexical item plus affix jumping was unknown. The children therefore delete the non-lexical element in order to produce a sentence that can be generated by the current grammar.

6.3.1 VN = VO and the First N = Subject hypotheses

The hypothesis that VN = VO is directly contradicted by results on nominal gerunds with preposition (CYS the kicking of the horse). Where the object was animate and could serve as either subject or object, 98-100% of the children took the horse as subject and not object.

The First N = Subject hypothesis, however, makes the correct predictions for these sentences since no noun precedes the verb. We must therefore look elsewhere to evaluate the First N hypothesis. The appropriate sentences are those where two nouns precede the verb:

(29) CYS the kids the bears fighting.

We found that 88.3% of the subjects did not follow the First N strategy in their answers to such sentences.

There exists evidence assembled by Bever⁴⁴ which appears to be inconsistent with our results. A significant number of children, who were four years old, used the First N strategy in cleft sentences:

(30) It's the horse the cow kisses

The explanation for the discrepancy between our results and Bever's may lie in different performance demands made by (29) and (30). In (29) the kids is interpreted as the indirect-object of show if the bears is the subject of fighting. If cow is the subject of kisses in (30), then horse has no

grammatical role until it is interpreted as the object of kisses. In effect children must keep horse in memory without a grammatical function until the subordinate clause is analyzed. Wanner et al⁴⁵ have shown that to "hold" a constituent in memory without assigning it a grammatical function makes considerable demands on processing power with adults. If children avoid this processing difficulty by requiring that constituents receive an immediate function assignment, then this might force them to make horse subject. This processing difficulty does not arise for kids in (29) because it can be immediately assigned the function of indirect-object in the matrix sentence. We arrive again at the conclusion that the First N strategy is not a rule of grammar. It may instead be a by-product of a processing constraint that affects a very limited range of constructions.

There is a second possible explanation that leads to the same conclusion. It may be the case that (29) is simpler than (30) simply because children have not yet learned the transformation that extracts an object to form a cleft construction. In that case we might predict that children would choose either horse or cow in relatively haphazard fashion because they had no strategy which supplied a clear analysis. This interpretation would be consistent with the uneven results which Bever obtained. Both of these interpretations lead to the conclusion that the First N strategy is not a part of grammar and, possibly, that it is not even a strategy. This agrees with Chomsky's claim that a child's principles for grammar construction are structure-dependent.

6.4 Pragmatic Hypotheses:

The overall result is surprising in light of the experimental design which explicitly encouraged the children to insert indirect-objects. There were only 18.3% insertions of all kinds in the 1164 eligible responses. Of these only 26/931 or 2.8% were indirect-object insertions. Of the total number of insertions 96% were just where they were required by syntax.

Why did children ignore opportunities to insert indirect-objects despite our instructions and the ever-present watching place (right before their eyes)? The source of our "surprise" may lie in a common bias toward vision in the usual understanding of context. In fact both sound and light are a part of the context that a child experiences. The question then becomes, which dominates, the sound that floods a child's ears or the light that floods his eyes? We exercise some control over the light because we choose where to focus but we cannot really choose what to hear (we have no earlids). We suggest therefore that a child's environment is dominated by sound whenever he is spoken to and that where he chooses to focus is often guided by his comprehension of what he hears. (This is not to deny that there is a feedback loop that evaluates sentences in terms of context).

6.4.1 Subject and Object Insertion

The central result is that subject and object are inserted in 40.1% of appropriate contexts while indirect-object was inserted in 2.8% of its contents. We suggest that pragmatic insertions are therefore primarily determined by the requirements of grammar and not context. One might offer an objection to this conclusion. Could it be that the "logic of action" requires subjects and objects but not indirect objects? For instance,

"hitting" cannot occur without someone to hit and be hit. This is true but it overlooks the fact that the child himself is available to perform any action. Since the children were required to manipulate the animals, it was easy for them to usurp the role of subject or agent. In fact many children did use themselves as agents in illustrating the sentence CYS the trees knocked down. The fact that the children inserted dolls as pragmatic subjects and objects means that they understood that the action was to be performed in terms of the dolls and not in terms of themselves. Therefore we conclude that they understood the experimental instructions that indicated the possibility of pragmatic-insertion as applying to dolls. However they applied the notion of pragmatic-insertion to their knowledge of grammar and not to the context, that is, to the fact that the "watching place" was often left empty. The grammar stipulates that subjects and some objects are obligatory (for particular verbs) while indirect-objects are optional. The fact that the children interpreted the instructions to insert dolls with reference to grammar is not surprising inasmuch as adults must frequently make the equivalent of pragmatic insertions in the comprehension of sentences. For instance, to understand the sentence John hated the dancing at the party a listener must infer imaginary dancers.⁴⁵

One might offer the following explanation for the low occurrence of pragmatic indirect-objects: perhaps the child regarded the experimenter as the implicit indirect-object. This explanation creates another discrepancy. If the child understood that subjects and objects need to be dolls why should s/he think that indirect-objects need not be dolls. We are led again to the conclusion that the child selected neither the experimenter nor a doll as indirect-object, but rather, since the category is optional in grammar, it was left unspecified.

6.4.2 Empty Objects

In principle object-insertion should be able to occur with reference to either deep structure or surface structure. Our results suggest, however, that it occurs primarily with reference to surface structure. We assume that phrases of the form the kicking of the horse derive from the horse's kicking by postposing the subject into object position. We found that the children put in pragmatic objects three times as frequently when the surface-structure position as well as the deep structure position were unfilled as when just the deep structure position was unfilled. One consequence of this result is that it suggests the reality of both deep-structure and surface-structure. That is, the children are aware that in the phrase the kicking of the horse, horse is both the subject and in object position, while in the horse's kicking the object position is open in both SS and DS. For some reason, which is not clear, they prefer both DS and SS positions to be unoccupied when object-insertion occurs.

6.4.3 Transformations vs. Pragmatic Insertion

There is a sense in which many of the sentences put transformations and pragmatic insertion into competition. That is, the child has a choice of undoing a transformation (post-posing the subject) in creating the kicking of the horse or inserting a pragmatic subject and treating horse as object. It is interesting that for the three sentences with just a post-

positional PP (3,18,31), there was no pragmatic insertion at all except in the case of (18) where the object of the preposition was an implausible subject. This result suggests that it is less difficult to analyze the sentence by itself than to make a joint inference on the sentence and the context together. This claim, of course, deserves more direct experimental scrutiny.

We conclude that the pragmatic insertion which existed, although minor, was sensitive to rather refined features of the syntax in the test questions.

6.4.4 Inferences

We turn now to the Pragmatic hypothesis III: the role of inferences in children's grammars. The primary result is that 41.2% of the responses to the sentences with prepositional phrases revealed an incorrect comprehension of prepositions. The sentences are unusual, but grammatical, and depend upon correct comprehension of prepositional phrases:⁴⁷

- (31) a. CYS the pushing by the dogs of the chickens
- b. CYS the kicking of the elephant by Bill
- c. CYS the rolling of the cow to the kids

As we reported above, there is a significant improvement with age. Maratsos and Abramovitch (1975) report, in addition, that of and by are virtually interchangeable in sentences with passive verbs. All of these studies suggest that relational prepositional phrases are in a jumble for children. It is interesting, however, that these prepositions are not confused with lexically complex prepositions like under, over, around, etc. They are confused with other relational prepositions. Thus by, to, and of are all interchanged. The children apparently infer, from little information, which relation is most natural for the verb and nouns chosen.

A second set of facts makes the situation more complex. The children responded differentially to two simple passives:

- (32) CYS the trees cut down by the camel
- (33) CYS the tractor hit by the sheep

In (32) 100% of the children chose trees as object and 80% chose camels as agent (the remainder chose camels as locative). In (33) the statistic shifts radically: 59% take tractor as object and 41% take tractor as subject and sheep as object. The variable in these results seems to be plausibility. Children infer a plausible relationship among the nouns in each sentence and the relationship is different for each sentence. It is difficult to imagine that the trees cut down the camels and very easy to imagine that the tractor hit the sheep.

Another set of responses suggests a limitation on the role of inference. Consider the following example sentence:

- (34) CYS Bill throwing the bears onto the roof.

If bears are seen as frightening and huge creatures, then it would be plausible to expect the bears to throw Bill onto the roof (or at least there might be uncertainty about who throws who). However 100% of the children

interpreted this sentence correctly (except for four who gave no answer). If we assume that inference operates where the grammar is not yet developed, then the results make sense, as we suggested in the introductory section (2.0). The children have a grammatical system which reveals that NVN = SVO. That interpretation is immune to revision in terms of plausibility. However the specific role of prepositional phrases has not been determined in the children's grammars. Therefore just the prepositional phrases may be open to inferences. This does not mean that children do not have some hypotheses about what individual prepositions may mean; rather it means that the child has not confirmed hypotheses about individual prepositions. This is then one way in which specific claims can be made about how syntactic knowledge and inference systems can interact in the process of learning.

6.4.5 Plausibility

One of our examples of post-nominal gerunds involved the following sentence:

(35) CYS the jumping of the fence.

We found that 77% of the children made the fence jump and hence were not deterred by the implausibility of a fence jumping. The 22% who supplied a pragmatic-subject shows that the plausibility factor has some effect where the children have a syntactic choice. It is remarkable that the number of children who made fence the object is not higher. A number of children were aware of the implausibility of the situation and said "you mean the fence is alive too" or "the fence can't jump" or "there's no fence that jumps". These quotations suggest that the syntax was able to operate without reference to plausibility. A post-syntactic check for "common sense" then appears to occur at the conscious level; at that point the child may re-analyze the sentence and seek another meaning.

7.0 Experiment II

We devised a second experiment, of smaller scope, to explore certain implications of the first experiment. In particular we sought to examine the following questions:

(36) A. The interruption hypothesis

1. Would children make more pragmatic insertions if anything appears between N and V?
2. Sentence type: It is the dog you see fighting the cow.

B. Do we find SS or structural (UG) responses for non-prepositional nominals?

1. Sentence type: CYS the mother the hugging sheep

C. If children are sensitive to articles, are they also sensitive to negatives (no/not) and to the adverb/adjective contrast

1. CYS the bears no fighting
2. CYS the dogs loud yelling/loudly yelling.

7.1 Methods

The procedure, materials, and design are like Experiment I. The subject population was smaller. There were twenty-one children in the experiment and thirty-two sentences. Some of the sentences addressed a different question which is not pertinent to our analysis here.⁴⁸

7.2 Interruption Hypothesis

This hypothesis involved specifically the comparison between four sentences with (37a) and four without (37b) material intervening between N and V.

- (37) a. It's the father you can show fighting bears
 b. CYS the father bringing the fence to the chickens

There were no differences in the proportion of sentences like (33a), which were interrupted, and those like (37b), which were not interrupted, in the number of pragmatic insertions they took: (37a) = 96.4%, $F < 1$.

7.3 Non-prepositional Nominals

These sentences involved the same hypotheses about UG and SS that were used in experiment I. The only difference is the fact that phrases of the form "the kicking of the horse" are replaced by phrases of the form "the kicking horse". We contrasted four sentences without a noun-marker with three that had a noun-marker. For instance:

- (38) a. CYS the mother the kissing kids
 b. CYS the father giving the fence the dog.

There was a larger proportion of pragmatic insertions for (38a), 64.5% (40/62) than for (38b), 7.4% (6/81); $t(20) = 3.31$, $p < .01$.

7.4 Negatives and Adverbs

We were unable to get a sufficiently large number of children to respond to these questions to obtain significance. The results are nevertheless suggestive. We sought to discover if children would distinguish the verbal negative (not) from the nominal negative (no) in the first instance:

- (39) a. CYS the bears no lying down
 b. CYS the chickens not lying down

The number of pragmatic insertions was four times as great for the no sentences as for the not sentences but there were only thirteen children (3-5 yrs old) involved: no 23.6% (9/38) and not (5.3% (2/38), $t(12) = 1.05$ $p > .10$.

The number of children responding in the adverb/adjective contrast was also small and the number who inserted pragmatic subjects were even fewer. The sentences involved contrasts of this kind:

- (40) a. CYS the father slowly walking
b. CYS the dog slow walking

The results are Adverbs 15.8% (6/38) and Adjectives 17.6% (9/51); $t(1,12) = .185$, $p > .25$.

7.5 Discussion

The sentences aimed at the interruption hypothesis reveal very clearly that the strategy used by children does not hinge upon a simple form of noun-verb adjacency. This is what is predicted by universal grammar which has many syntactic rules that do not require adjacency.

The sentences involving adjectival gerunds (the kissing children) show a stronger recognition of noun-markers (69%/48%) than the sentences used in Experiment I. This may be linked to ambiguities in the interpretation of prepositional phrases that are not involved in these phrases. In addition a few sentences which involved some (e.g. CYS the dog some fighting bears) instead of the showed that a less frequent article made no difference.

The contrasts between negatives is, in a sense, remarkable because it hinges on the phonological difference between no and not. A more successful method of elicitation might reveal that children of three and four have a good understanding of the distinction.

The adverb/adjective contrast was extremely weak. This result corresponds in some measure to the fact that adverbs and adjectives are not always clearly distinguished by adult speakers, especially in certain dialects. Both the negative and adverb/adjective examples give further evidence against the interruption hypothesis, since the overwhelming tendency was not to make pragmatic insertions.

The results of our second experiment, in general, support the results found in the first experiment. The second experiment approached both the limited of subtlety in the nominal/verbal gerund distinction and the limits of our experimental paradigm.

Conclusion:

We have found evidence that all three kinds of comprehension strategy play a role in children's reception of language (universal grammar, surface-structure strategies, pragmatic strategies). In our discussion we have argued that the grammar is the centerpiece in these strategies. First the children exhibit knowledge of a subtle linguistic distinction at a surprisingly young age. We did not expect three-to-four year olds to be sensitive to the control implications of articles, nor did we expect that children would master articles before prepositions. Second we argued that the reason nounphrase markers are recognized early, before compound stress, is that the nounphrase plays a role in other hypotheses. Third the grammar is the standard against which the adjustment rules work; the SS-strategies, we argued, are built to convert partially unknown sentences into ones generated by the grammar. Fourth we found that the pragmatic strategies were,

primarily, responsive to syntactic structure and not to context. Fifth we found that inference procedures appeared to function just where grammatical strategies were non-existent or insecure. These arguments demonstrate the presence of interactions in language acquisition. Nevertheless the interactions depend upon a syntax that is autonomously defined.

The arguments above suggest why children learn to recognize articles at an early age. Our earlier theoretical discussion suggests how: the recognition of articles functions as a trigger for the invocation of a complex structure of knowledge.

Footnotes.

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1. Chomsky, (1975), p. 121.
2. op. cit. p. 44.
3. In principle we must analyze theory and data together. Without particular data there could be an infinite set of plausible theories of acquisition. And without theory there is an infinite range of data interpretation. A "robust" theory (in the biological sense) is one that develops a good fit between theory and data.
4. Versions of these theories are present in Slobin (1973), Bloom (1973a), Bever (1970b), Sinclair (1973) and many others. The synthesis presented here may be in agreement with their positions.
5. Summarized in Clark and Clark (1977).
6. Roeper (1973a), Miller and Johnson-Laird (1976).
7. Chomsky (1975) p. 41-43 "Suppose that there is no sharp delimitation between those semantic properties that are "linguistic" and those that form part of common-sense understanding, that is, the cognitive system dealing with the nature of things named, described, or discussed. Thus lexical items might be related by principles that form a kind of central core for a system of common-sense beliefs..."

8. Slobin (1966)
9. Other specific connections between transformations and meanings are possible. Bach (1971) suggests that there may be universal features of question-formation. Thus as soon as a child discovers by inference (or through intonation) that a question is being asked, he may know that a leftward movement transformation could be involved in the sentence. Similar constraints could be specific for other constructions.
10. Chomsky (1969)
11. See Solan (to appear) for evidence that this deep structure version is in fact controlled by children and for other evidence showing that children distinguish a different DS for Mary is Pretty to look at (which cannot be paraphrased *it is pretty to look at Mary).
12. I refer primarily to the Piagetian School.
13. Unfortunately it is not easy to show that the properties of control and anaphora are found elsewhere in the grammar.
14. Putnam (1962), Goodman (1951), Skinner (1957), Piaget (1970), Quine (1960), and many others.
15. Bever (1970b), Brown (1973), and many others cited therein.
16. Fodor (1975). Fodor argues that the cognitive language must meet the joint requirements of several modes of knowledge (visual, auditory, tactile, etc). We can expect that language will share some features of other forms of knowledge simply because translation is possible (we can talk about what we see) and diverge from them (we see three-dimensionally) in other features, because communication must meet requirements different from visual perception.
17. Kiparsky delivered a lecture on this topic at Bologna (1972), referring to material discussed in Fiengo (1974).
18. See also Culicover and Wexler (1974) for an argument about how base structure is learned partially through semantic assumptions. In Chomsky's system (1975b) the syntactic analyses would have to meet the requirements of logical form.
19. See Bever (1970).
20. See also Kimball (1973, 1975), Grosu (1977), Fodor, Bever and Garrett (1974), and others.
21. Chomsky (1975), p. 119.
22. Menyuk (1969), Limber (1973), Sheldon (1974), Roeper (1972), McNeil (1970), Ingram (1975) are a sampling in which UG is always obeyed.

23. See Roeper (in preparation) for a more extensive discussion of these issues.
24. Chomsky (1975), p. 121.
25. For instance it is not clear that all subjects are initially agents. Nor is it clear that girl jump should be described as NV rather than NP VP, or that pivot-open is a more appropriate initial classification.
26. The notion of "data-driven" was suggested to me by Ed Matthei.
27. See Roeper (1972).
28. See Tavakolian (1977), Solan and Roeper (1977).
29. See Roeper, Stack, Carlson (1977).
30. See Roeper (in preparation). The role of disjunctive ordering would allow there to be just one deviation from deep structure in early phrases of the grammar, under the assumption that every transformational rule was disjunctively ordered with respect to the rest. This could explain why children have wh-movement and auxiliary-inversion but cannot apply them both at once. This would be a powerful constraint on the acquisition device. It might require a distinction among kinds of transformations so that affix-hopping does not comprise a counterexample.
- E.S. Williams (personal communication) has suggested that the problem of the lack of negative data could be partially solved by a restriction against optional rules. If a child assumes that all rules are obligatory, then he will quickly disconfirm this hypothesis if a rule is optional (because it will fail to occur). The opposite claim does not work. If a child assumed that a rule is optional, he would never encounter evidence to prove that it was obligatory.
31. A great deal of attention has been paid to the hypothesis that the mother controls the input to the child. We suspect that the child must be equipped to select data him or herself. The mother is then redundant at best and probably not really able to provide sentences with the subtle precision that the HG requires. Thus many of the utterances of the Mother will still have to be excluded by the child from analysis. Mothers do not, for instance, use only weak verbs (with -ed) and only later use strong verbs, though this sequence might facilitate acquisition of morphology.
32. The learning of lexical items involves a different set of hypotheses that follow from the word-formation component. Through these hypotheses "unknown" words eventually become known.
33. This is, therefore, a version of a perceptual strategy proposed by Bever (1970). He proposes it in lieu of grammar. We suggest it as a reflection of grammar.
34. That is, we suspect that they would not be "scattered" in value; see Chomsky (1965).

35. An anonymous reviewer has suggested that one could make the following proposal: any item may be moved or deleted. This proposal would have the restriction that lexically-filled items may not be involved. The proposal plus the restriction are extensionally equivalent to our proposal. It might be preferable to our proposal, but ours has the virtue that it assumes transformational rules and deletion rules as separate. More work must be done before the best formulation is clear.

36. See Chomsky's discussion of the "extensional" version of a language-acquisition device.

37. Horn (1975) refines the argument in Wasow and Roeper (1972) in a way that meets objections by Schachter (1976). He shows that the control argument applies to the ACC-ING construction, and not the POSS-ING construction. Thus the arguments in Wasow and Roeper (1972) hold over a slightly smaller range of data.

38. This criterion does not apply to some verbs. See Horn (1975).

39. These ideas are proposed by Bever, although he might not endorse the extension of them.

40. See also Maratsos and Abramovitch (1975) and also Bresnan (1978) for a discussion of how passives are learned with rules of semantic composition which is compatible with our discussion of the delayed learning of prepositional phrases.

41. Maratsos (1974)

42. Gleason (1957), Atkinson-King (1973)

43. See Horn (1975), Bach and Horn (1976), Chomsky (1977b)

44. Bever (1970b), Carroll and Tanenhaus (1975)

45. Wanner and Maratsos (unpublished)

46. See Tavakolian (1977) for extensive evidence that children spontaneously make pragmatic insertions in other kinds of well-defined syntactic contexts.

47. A recent replication of this experiment by John Bacon (University of Massachusetts) showed that a group of children 3-5 years old misconstrued the by-phrase 75% of the time in sentences with more than one post-gerund PP.

48. The sentences were like Can you make the bear fall on the horse, after sneezing. They were comprehended in a correct way in almost every case.

APPENDIX.

1. Can you show the sheep near Mary?
2. Can you show the kids the cow fighting?
3. Can you show the kicking of the horse?
4. Can you show Mary hitting the dog?
5. Can you show the horse and the cow fighting the sheep?
6. Can you show the sheep the tractor? (omitted after 1st child)
7. Can you show the fence blinking to the dog?
8. Can you show Mary lying down?
9. Can you show the cut down trees?
10. Can you show the cow's kicking of the horse?
11. Can you show Mary to the kids on the tractor?
12. Can you show the chickens fighting to the dog?
13. Can you show the cow the hitting of the horse?
14. Can you show Mary the jumping?
15. Can you show the sheep the pushing by the dog of the chickens?
16. Can you show the rolling of the cow to the kids?
17. Can you show the cow kicking?
18. Can you show the jumping of the kids?
19. Can you show the trees cut down?
20. Can you show the horse-hitting chicken?
21. Can you show the kids the bears hitting?
22. Can you show the kicking of the elephant by Bill?
23. Can you show the trees blown down by the camel?
24. Can you show the lion and the turtles kissing?
25. Can you show the bear-kicked camel?
26. Can you show the kids the tractor sleeping?
27. Can you show the knocked down fence to the elephant?
28. Can you show Bill throwing the bears onto the roof?
29. Can you show the rollong of the sheep by the turtles?
30. Can you show the elephant's kicking by the camel?
31. Can you show the jumping of the fence?
32. Can you show the tractor hit by the sheep?
33. Can you show the kids the hitting?
34. Can you show Bill the elephant-kicked lion?
35. Can you show the sheep-kissing turtle?
36. Can you show the fence near the tractor?
37. Can you show the trees blown over to the elephant?
38. Can you show the kissing by the kids of the camel?